Curriculum

M.Tech
Computer Aided Design Manufacture and Automation

July, 2025

School of
Engineering and Technology

Department of
Mechanical Engineering Education

Deemed to be University under
Distinct Category

NATIONAL INSTITUTE OF TECHNICAL TEACHERS' TRAINING AND RESEARCH (NITTTR), BHOPAL
(Deemed to be University under Distinct Category)
Ministry of Education, Government of India
Shamla Hills, Bhopal – 462 002
Madhya Pradesh, India

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Preface

National Institute of Technical Teachers' Training and Research (NITTTR), Bhopal is a unique premier institution under the MoE, GOI for improving the quality of the higher education system in India, especially the technical education system of the country. It was established in 1965 as the Regional Training Institute (RTI) for the western region. Later in 2003, it was upgraded as NITTTR, and recently in 2024, NITTTR was granted the status of a Deemed University under Distinct Category.

It is to mention here with great pride and immense pleasure that NITTTR Bhopal has launched 05 M. Tech. programmes in engineering, one MBA programme,2 MSc programmes. 09 PG Diploma and 03 diploma programmes from 2025-26. Two batches have already been passed out in the Diploma in Semiconductor Packaging (OSAT/ATMP). The institute has also developed the centre of excellence in Siemens with 11 High-Tech Laboratories, a Centre of Excellence for OSAT/ATMP and a Centre for Experiential learning (CEL) for providing hands-on experience to the learners. The PhD programme in Schools of engineering, sciences, management and creative education &liberal arts has already been launched.

The learner-centric outcome-based curricula have been developed for all 08 PG programmes. These curricula with multidisciplinary approach are aligned to the philosophy of NEP:2020 and NCrF, with provision of ME&ME, flexibility and holistic development, catering to nurture intellectual, emotional, psychological, social, moral and physical wellbeing of the learners to be good human being and ensuring success in profession of their choice in industry/research/academic/start-ups.

NEP recommends integrating vocational/technical education with general education and strengthening industry-academia collaboration in HEIs. Experiential learning is integrated in the curriculum to be practiced by the learners through hands-on experience at all high-tech labs and centres of excellence at the institute. Project/ problem based learner centric flexible learning environment is propagated for life-long learning, even from their workplace.

By formally embedding unique features and OBE principles into our M. Tech, MSc. and MBA programmes, NITTTR is committed to nurturing competent, responsible and forward-thinking, futuristic educators, technologists & researchers. This initiative complements our broader mission of fostering and integrating pedagogical excellence into engineering, science and management streams for quality-driven education.

The effective implementation of these curricula using advanced pedagogical methods and assessment reforms will provide high-quality, learner-centric education that will meet the expectations of industry, academia and research.
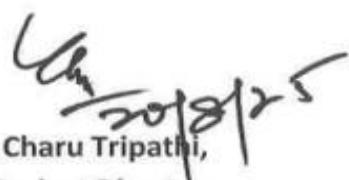
Prof. (Dr.) Chandra Charu Tripathi,
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2. Introduction:

Computer Aided Design Manufacture and Automation programme has an outcome-based, learner-centric curriculum with a comprehensive and balanced mix of core discipline technology and educational technology, empowering students to excel in impactful teaching, research, and service to the Industry. The programme has a holistic and multidisciplinary educational approach that nurtures intellectual, aesthetic, social, physical, emotional, and moral capacities in an integrated manner. This will be achieved with an innovative way of curriculum implementation, such as Problem and Project-based learning, opportunities for self-learning, providing Industry connect, assigning inter-disciplinary projects, emphasis on project management and finance, concern for professional ethics, environment, and society, etc.

To achieve the goal of holistic and multidisciplinary education, NITTTR Bhopal is developing flexible and innovative curricula of these PG programmes, incorporating credit-based courses with an option of Multi-Entry and Exit and projects in community engagement, environmental education, and Bhartiya Knowledge System. The normal duration of M.Tech. programme, including the thesis, will be 2 academic years (4 spells offline + 2 spells in online mode). Each offline spell will have a 5-week contact duration in the institute. The teachers/working professionals/enthusiastic learners who have already done M.Tech. can also join this interdisciplinary programme for capacity building.

3. Approach for Scientific Design & Development of Curriculum:

The curriculum is designed after identifying the current job title of the industry where pass-out students will be absorbed. Later, different job skills required for the professionals are identified. These job skills are further mapped with the courses to be offered. Course outcomes for all the courses are also identified based on the job skills required for the professionals.

4. Unique Features of the Curriculum:

- The programme is aligned with the philosophy and requirements of NEP and NHEQF.
- Outcome-Based, learner centric curriculum with comprehensive and balanced mix of different category of courses as mentioned in Table-1.
- The duration of M.Tech. Programme is two academic years, (4 offline spells and 2 online spells running in parallel with offline spells). The online spell-1 will run parallelly with offline spell 1 and 2. The online spell-2 will run parallelly with offline spell 3 and 4. The representation of offering of programmeis mentioned in Figure 1. Each offline spell is of 15 weeks duration. This includes one week end-term examination and 5 weeks of mandatory classroom/lab based study. The total credit and marks are mentioned in Table-2
- The provision for Recognition of Prior Learning is also included.
- Dynamic curriculum with option of inclusion of diversified courses as per the changing needs of the industry.
- Holistic and multidisciplinary educational programme
- Inter-disciplinary research based project, emphasis on project management and finance, creativity and innovation, concern for professional ethics, environment and society etc.
- Credit-based courses with an option of Multi- Entry and Exit and projects in community engagement, environmental education, and Bhartiya Knowledge System.
- Recognition of identified SWAYAM / NPTEL courses.

Figure -1 Representation of Offering of Programme
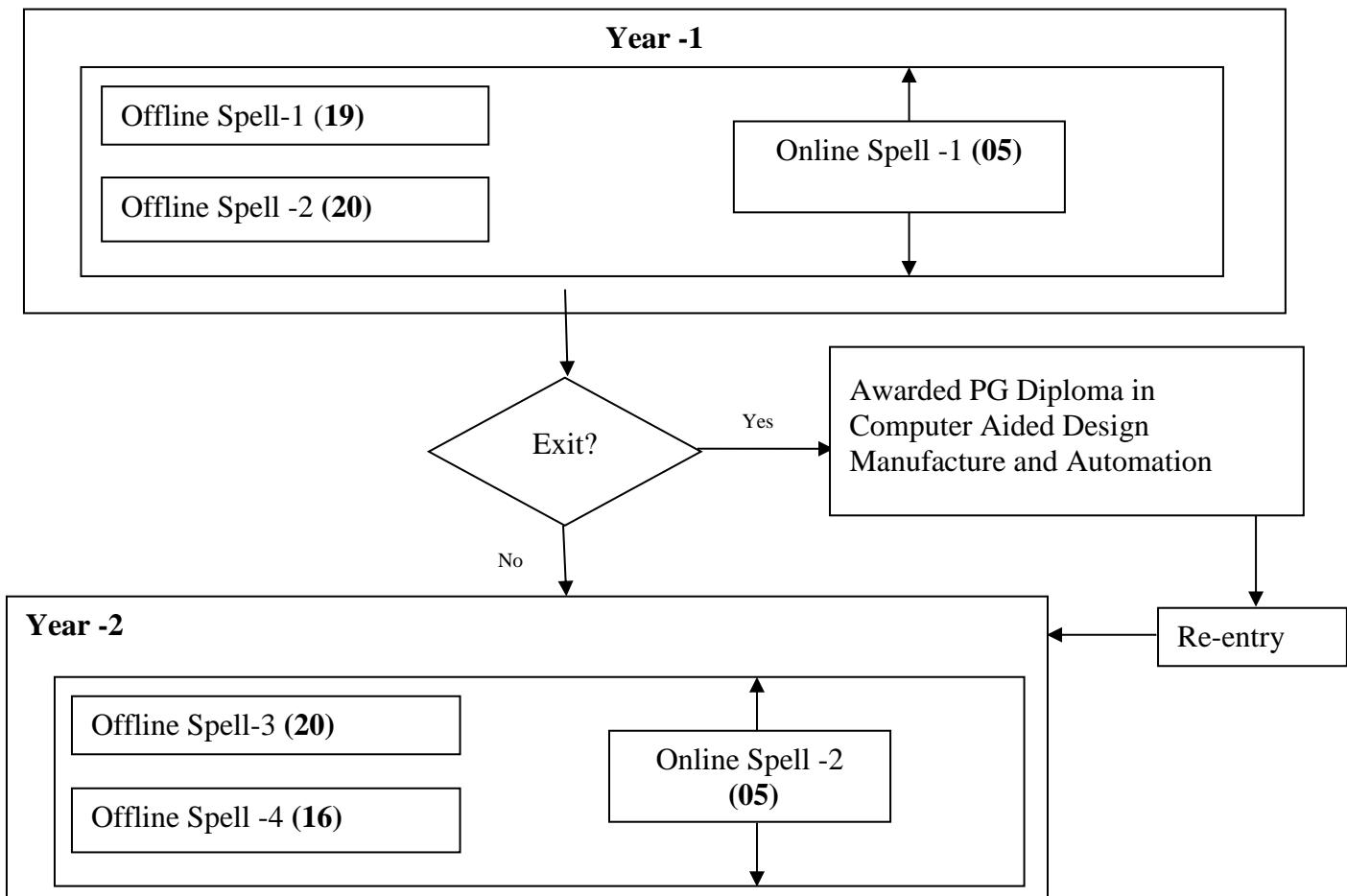
5. Vision & Mission Statements of the Institute:

Vision: To be the world class leader for integrated development of technical education and training systems catering to the changing needs while achieving highest level of client satisfaction, quality, professional values and contributing to technological, economic and social development of the country.

Mission: NITTTR Bhopal will act as a centre of excellence to: Intensify teacher education for improving quality and performance of technical institutions. Make the technical education a vibrant learning system for producing competent manpower to steer technological and economic development. Provide a wide spectrum of client driven services and products through various modes. Strengthen networking and synergic partnership with technical institutions; industries, field agencies, and premier national and international organizations. Promote creativity, innovations, research and development, professional management practices, concept of learning organization, benchmarking and economics of education amongst client systems. Enthuse the spirit of professionalism, values and work ethics, networking and partnership with industry and other organizations and technical institutions.

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6. Vision & Mission Statements of the Department:

Vision: Be an acknowledged center of excellence in the area of Mechanical Engineering Education, Research, and Training.

Mission: The department commits itself to accomplish following missions:

- Offer demand-based long-term and short-term education and training programs through various modes.
- Undertake research in emerging & interdisciplinary areas of Mechanical Engineering, Engineering education & training, addressing contemporary academic, industrial/ professional, & societal issues.
- Undertake Outcome-Based Curriculum Development in emerging areas of Mechanical Engineering /Design and allied disciplines
- Network with industries, national and international institutions, Research organizations, community & service organizations for synergic partnership.

7. Programme Educational Objectives (PEOs):

PEO1: Have a successful technical/professional career in educational institutions.

PEO2: Have a successful technical/professional career in Industry, Research & other organisations.

PEO3: Pursue higher studies and continue their professional development.

PEO4: Be a successful Entrepreneur in providing services in the Design, Manufacturing, and Automation industry as well as allied areas and allied areas

8. Programme Outcomes (POs): -As per NBA

PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.

PO-2 An ability to write and present a substantial technical report/document**.**

PO-3 Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO-4 Use descriptive statistics for decision-making using AI by organising, analysing, and visualising large, complex datasets while maintaining the security and quality of data to ensure its access control and accuracy.

PO-5 Analyze datasets with supervised learning methods for functional approximation, classification, and forecasting, and unsupervised learning methods for dimensionality reduction and clustering.

9. Employment Potential:

Sample Employment and self-employment avenues are mentioned below-

9.1. Employment Avenues:

- CAD Engineer
- CAE Engineer
- Product Development Engineer
- Machinery Modelling and Design Engineer

- Scientist in R&D organizations
- Academic Faculty
- Process Engineer
- Entrepreneur, etc.

9.2. Self-Employment Avenues:

- Automation and Robotics Integration Business
- Product Development for Assistive Devices
- Industrial Design Freelancing
- Customized Product Design and Manufacturing
- 3D Printing and Rapid Prototyping Services
- Design and Simulation Consultancy
- IoT-Enabled Smart Manufacturing

10. Features of M. Tech. Programme in Computer Aided Design Manufacture and Automation

This M.Tech. The programme emphasizes hands-on practical training in the three major disciplines of product development, namely, Design, Manufactruing and Automation. The modular nature of the program, accommodating a hybrid learning approach, makes it suitable for working professionals also. This Programme aims to provide students with this unique combination of skills.

The programme consists of 4 offline spells and 2 online spells, totaling 81 credits. There is a provision for students to exit the course after completing a second offline spell, followed by one additional exit course, to enhance their skills in the area of computer-aided design manufacture and automation. The curriculum includes different courses to develop professional-specific skills in the technology domain and in pedagogy, as well as in each module, including the Capstone project.

Students have the option to choose courses from the list of Program Elective Courses to develop professional skills related to the area of Computer Aided Design Manufacture and Automation. Similarly, they can choose courses of their liking from the list of Open Elective Courses to develop their specialization in the given area. Through these electives, each student can choose his/her pathway to complete the program with present and future industrial requirements.

Programme Structure (PS) with Teaching & Learning and Assessment Scheme:

1.	**Title of Programme**	:	M. Tech. in Computer Aided Design Manufacture and Automation
2.	**Board of Studies**	:	Computer Aided Design Manufacture and Automation
3.	**Duration of Programme**	:	Two Years
4.	**Entry Qualification**	:	B. Tech./ B.E.
5.	**Total Marks**	:	3610
6.	**Total Credits**	:	81
7.	**Total Number of Courses**	:	21

Summary of Credits and Marks

S. No	Spell	Credits	Total Marks
Year -1			
1.	Offline Spell - 1	17	730
2.	Offline Spell –2	20	810
3.	Online Spell – 1 (PD& NEP)	05	250
	Total	**42**	**1790**
Year-2			
4.	Offline Spell - 3	18	770
5.	Offline Spell - 4	16	800
6.	Online Spell – 2 (PD & NEP)	05	250
	Total	**39**	**1820**
	Grand Total	**81**	**3610**

Category wise Courses

S. No.	Course Category	Abbreviations	Number of Courses	Total Credits
1.	Programme Core Courses	PCC	08	32
2.	Programme Elective Courses	PEC	02	06
3.	Stream Specific Diversified Courses (if applicable)	SSC	-	-
4.	Open Elective Courses (Common Basket)	OEC	01	03
5.	Project, Dissertation	PD	03	29
6.	Pedagogy Courses	PC	04	08
7.	NEP Courses	NEP	03	03
	Total		**21**	**81**

Computer Aided Design Manufacture and Automation- CAMA
Teaching & Learning and Assessment Scheme (Year – 1)
Offline Spell – 1

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA01	PCC	Computer Aided Design & Analysis	45	15	45	15	120	04	30	70	20	-	20	30	170
CAMA02	PCC	Industrial Automation	45	15	45	15	120	04	30	70	20	-	20	30	170
CAMA03	PCC	Advanced Engineering Materials	45	15	45	15	120	04	30	70	20	-	20	30	170
CSEB05	PCC	Artificial Intelligence & Machine Learning	30	15	45	30	120	04	30	70	20	-	20	30	170
NEP01-05	NEP*	NEP Courses	15	-	-	15	30	01	25	-	25	-	-	-	50
		Total	180	60	180	90	510	17	145	280	105	-	80	120	730

Legends:

Course Category: Programme Core Courses (PCC), Programme Elective Courses (PEC), Stream Specific Diversified Courses (SSC), Open Elective Courses (OEC), Project (PD), Dissertation (PD), Pedagogy Courses (PC), NEP Courses (NEP)

*Basket of NEP Courses: Sports, Yoga & Meditation (NEP01)/ Open Educational Resources (NEP02)/ Professional Ethics (NEP03)/ Financial Literacy (NEP04)/ Engineering Economics (NEP05)

Offline Spell – 2

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA04	PCC	**Digital Manufacturing**	45	15	45	15	120	04	30	70	20	-	20	30	170
CAMA05	PCC	**PLC and PLC Programming**	45	15	45	15	120	04	30	70	20	-	20	30	170
CAMA06	PCC	**Optimization and Simulation**	45	15	45	15	120	04	30	70	20	-	20	30	170
CAMA07-09	PEC	**Program Elective Course-1**	-	-	-	-	-	03	-	-	-	-	-	-	100
PD01	PD	**Project**	-	-	45	105	150	05	-	-	200	-	-	-	200
		Total	135	45	180	150	510	20	90	210	260	-	60	90	810

Legends:

Course Category: Programme Core Courses (PCC), Programme Elective Courses (PEC), Stream Specific Diversified Courses (SSC), Open Elective Courses (OEC), Project (PD), Dissertation (PD), Pedagogy Courses (PC), NEP Courses (NEP)

Programme Elective Course-1: (offering through the NPTEL platform): Introduction to Robotics (CAMA07)/ Design & Implementation of Human-Computer Interfaces (CAMA08)/ System Design for Sustainability (CAMA09)

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Online Spell –1

The online spell -1 will be offered parallelly with offline spell -1 and offline spell -2

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
PC01	PC	**Research Methodology**	30	-	-	30	60	02	30	50	20	-	-	-	100
PC02	PC	**Curriculum & Assessment**	30	-	-	30	60	02	20	30	50	-	-	-	100
NEP06	NEP	**Indian Knowledge System (IKS)**	15	-	-	15	30	01	25	-	25	-	-	-	50
		Total	75	-	-	75	150	05	75	80	95	-	-	-	250

Legends:

Course Category: Programme Core Courses (PCC), Programme Elective Courses (PEC), Stream Specific Diversified Courses (SSC), Open Elective Courses (OEC), Project (PD), Dissertation (PD), Pedagogy Courses (PC), NEP Courses (NEP)

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Year – 2

Offline Spell – 3

Course Code	Course Category	Course Titles	Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		Total Marks (TA+TWA+LA)
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA10	PCC	**Finite Element Analysis**	45	15	45	15	120	04	30	70	20	-	20	30	170
CAMA11-13	PEC	**Program Elective Course-2**	-	-	-	-	-	03	-	-	-	-	-	-	100
CAMA14-15	OEC	**Open Elective Course**	-	-	-	-	-	03	-	-	-	-	-	-	100
PD02	PD	**Dissertation Part- I**	-	-	90	150	240	08	-	-	300	100	-	-	400
		Total	45	15	135	165	360	18	30	70	320	100	20	30	770

Legends:

Course Category: Programme Core Courses (PCC), Programme Elective Courses (PEC), Stream Specific Diversified Courses (SSC), Open Elective Courses (OEC), Project (PD), Dissertation (PD), Pedagogy Courses (PC), NEP Courses (NEP)

Programme Elective Course -2: (offering through the NPTEL platform)- Introduction to Mechanical Micromachining (CAMA11)/ Multi-Objective Design Optimization (CAMA12)/ Supply Chain Management (CAMA13)

Open Elective Course: (offering through the NPTEL platform)- 3D Printing and Design for Educators (CAMA14)/ Product and Brand Management (CAMA15)

Note: Learners may also opt Open Elective Course offered by other PG programmes as well as from any category of the courses of the same spell/ MOOC courses.

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Offline Spell - 4

Course Code	Course Category	Course Titles	Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		Total Marks (TA+TWA+LA)
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
PD03	PD	**Dissertation Part - II**	-	-	105	375	480	16	-	-	500	300	-	-	800
		Total	**-**	**-**	**105**	**375**	**480**	**16**	**-**	**-**	**500**	**300**	**-**	**-**	**800**

Legends:

Course Category: Programme Core Courses (PCC), Programme Elective Courses (PEC), Stream Specific Diversified Courses (SSC), Open Elective Courses (OEC), Project (PD), Dissertation (PD), Pedagogy Courses (PC), NEP Courses (NEP)

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Online Spell –2

The online spell -2 will be offered parallelly with offline spell -3 and offline spell -4 in Second Year

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
PC03	PC	MOOC Creation	30	-	-	30	60	02	20	30	50	-	-	-	100
PC04	PC	Learner Centric Instructional Methods	30	-	-	30	60	02	30	50	20	-	-	-	100
NEP07	NEP	Intellectual Property Rights (IPR)	15	-	-	15	30	01	25	-	25	-	-	-	50
		Total	75	-	-	75	150	05	75	80	95	-	-	-	250

Legends:

Course Category: Programme Core Courses (PCC), Programme Elective Courses (PEC), Stream Specific Diversified Courses (SSC), Open Elective Courses (OEC), Project (PD), Dissertation (PD), Pedagogy Courses (PC), NEP Courses (NEP)

Course Curriculum Detailing- Offline Spell -1

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A)	**Course Title:** Computer Aided Design & Analysis	
B)	**Course Code:** CAMA01	
C)	**Pre- requisite Course (s):**	

D)   **Rationale:** This Course provides information for engineers on computerizing their design processes. Most engineering companies use calculations on geometry during design processes. Product visualization and analysis are required in all stages of product development. This course shows how to replace current manual techniques by computer. The course focuses on strengthening the theoretical and practical knowledge of the students in the core areas of design and analysis in product development so as to meet the needs of the industries as well as R&D organizations. Hands on sessions are conducted on commercial CAD software, Programming language. Students will be able to use and analyse Computer Aided Design methods and procedures in product development.

E)   **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following industry-expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
CAMA01.CO1	Identify CAD methods and procedures in various product development.
CAMA01.CO2	Apply algorithms to solve geometric transformation problems by visualizing various objects.
CAMA01.CO3	Implement curve and surface representation algorithms for modelling and analysis of various shapes.
CAMA01.CO4	Create various product models using the concepts of solid modelling.
CAMA01.CO5	Analyse data exchange formats in the development of various products.

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F)   Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)				
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/document.	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	**PO-4** An ability to use modern tools and techniques related to CAD, Manufacturing and Automation.	**PO-5** An ability to apply optimization techniques to provide competitive optimal solution to the real world of work problems.
CAMA01.CO1	2	2	3	3	-
CAMA01.CO2	-	-	3	3	-
CAMA01.CO3	-	-	3	3	-
CAMA01.CO4	-	-	3	3	-
CAMA01.CO5	-	-	-	3	-

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA01	PCC	Computer Aided Design & Analysis	45	15	45	15	120	04	30	70	20	-	20	30	170

H)   Course Curriculum Detailing: For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP: 2020, unique features like Green skills, Multidisciplinary Aspects, Societal Connect, IKS, Renewable Energy are integrated appropriately.

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I)   **Theory Session Outcomes (TSOs) and Units:**

Major Theory Session Outcomes (TSOs)	**Units**	**Relevant CO Number(s)**
TSO 1a. Explain the product development stages and lifecycle. TSO 1b. Outline the historical developments of CAD. TSO 1c. Identify the requirements of CAD in product development. TSO 1d. Identify the process parameters in CAD product development. TSO 1e. Select appropriate hardware and software for the given situation.	**Unit-1.0 Computer Aided Design and Analysis** 1.1 Product life cycle 1.2 Historical development of CAD 1.3 Role of CAD in the design process 1.4 CAD hardware and software 1.5 Parametric solid modelling software: methods and procedures used in product modelling.	CO1
TSO 2a. Create objects using boundary points. TSO 2b. Implement Transformation and visualization for the given objects. TSO 2c. Represent given objects and their transformations in a homogeneous coordinate system. TSO 2d. Explain the algorithms to the given geometric transformation problems for visualisation. TSO 2e. Explain clipping and hidden line removal on objects for a given condition.	**Unit-2.0 Geometric Transformations** 2.1 Representation of points 2.2 Transformation of geometric models: translation, scaling, reflection, rotation and sharing 2.3 Homogeneous representation, concatenated transformations 2.4 Inverse transformations 2.5 Clipping-hidden line removal	CO2
TSO 3a. Create a parametric representation of the given analytic curves. TSO 3b. Analyse parametric representation of the given analytic curves TSO 3c. Analyse the parametric representation of synthetic curves. TSO 3d. Illustrate various curves represent algorithms for analysis of the given shape.	**Unit-3.0 Plane and Space Curves** 3.1 Parametric representation of analytic curves: circle, ellipse 3.2 Parametric representation of analytic curves: parabola and hyperbola, Conic sections 3.3 Parametric representation of synthetic curves like Cubic splines, Bezier curve, B-spline curve. 3.4 Curve Design, Parametric Space of a Curve, Re-parameterization 3.5 Rational Polynomials, NURBS	CO3
TSO 4a. Analyse algebraic and geometric forms for the given surfaces. TSO 4b. Create the given type of surface representation. TSO 4c. Implement the synthetic surfaces computationally. TSO 4d. Apply Euler operators to validate the given objects. TSO 4e. Apply Euler regularised Boolean Operators to create the given objects.	**Unit-4.0 Surfaces and 3D Modeling** 4.1 Fundamental of Surface Design, Parametric Space of a Surface 4.2 Re-parameterization of a Surface patch, sixteen-point form 4.3 Four Curve Form, surfaces of revolution, Sweep surfaces 4.4 Quadric surfaces; Bilinear surfaces; Ruled and developable surfaces, Bezier surfaces; B-spline surfaces.	CO3 CO4

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 4f. Create a boundary representation of a given object. TSO 4g. Create a solid model for the given object using the constructive solid geometry approach.	4.5 Solid modelling: Topology and Geometry, set theory, Euler Operators, 4.6 Regularized Boolean Operators, Boundary Representation, Constructive Solid Geometry.	
TSO 5a. Inspect the neutral and native formats used in product development. TSO 5b. Apply the direct and indirect translation of the product model across given applications. TSO 5c. Analyse given neutral file formats for product development.	**Unit-5.0 Data Exchange Formats** 5.1 CAD/CAM data exchange formats. Direct and Indirect translators 5.2 Neutral file formats: Data Exchange Format (DXF), Standard Triangular Language (STL) 5.3 Neutral file formats: Initial Graphics Exchange Specification (IGES) 5.4 Standard for the Exchange of Product Data (STEP 3D) format.	**CO5**

J)　　Suggested Laboratory Experiences:

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number(s)
LSO 1.1 Develop models of 2D Geometries. LSO 1.2 Analyse 2D Drawings.	1.	Sketching basic and complex geometries using various constraints and dimensions using CAD modelling package.	CO1
LSO 2.1 Develop models of 3D components. LSO 2.2 Analyse Part Drawings.	2.	Modelling 3-dimensional objects using the part design workbench using CAD modelling package.	CO1, CO4
LSO 3.1 Develop assembly models of product models. LSO 3.2 Analyse assemblies of product models.	3.	Modelling assemblies of product models containing multiple parts using an Assembly workbench using a CAD modelling package.	CO1, CO4
LSO 4.1 Create production drawings.	4.	Generating drafting and production drawings using the layout workbench and CAD modelling package.	CO1, CO4
LSO 5.1 Write a computer program for 2D transformation for simple cases.	5.	2D Transformations of objects using a programming language – simple cases.	CO2
LSO 6.1 Write a computer program for 2D transformation with given conditions for complex cases.	6.	2D Transformations of objects with specified conditions using a programming language – complex cases.	CO2
LSO 7.1 Write a computer program for 3D transformation with given conditions	7.	3D Transformations of objects with specified conditions using a programming language.	CO2
LSO 8.1 Write a computer program for a given synthetic curve. LSO 8.2 Analyse the created synthetic curve	8.	Generation of synthetic curves for given conditions using a programming language.	CO3

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number(s)
LSO 9.1 Write a computer program for the given synthetic surface. LSO 9.2 Analyse the created synthetic surface	9.	Generation of synthetic surfaces for given conditions using a programming language.	CO3

K)   Suggested Research Based Problems:

      i. Development of an algorithm for the generation of NURBS surfaces for defining any kind of surface.

      ii. Development of an algorithm to find curves/points for two intersecting surfaces

      iii. Development of an algorithm for the generation of B-spline surface for user-defined conditions and analyzing the algebraic and geometric conditions.

L)   Suggested Term Work (TW):

a. Assignment(s):

- Write 16 points form for a given surface.
- Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Seminar Topic:

- Visualization of solid models using points representation for identified industrial products.
- Geometric transformations and visualization for given solid models.
- Bezier / B-spline cure for given points: properties, advantages and limitations.
- STL, STEP, and IGES formats for the product data exchange.

c. Portfolio presentation:

- Presentation of student portfolio on the labs performed.

M)   Suggested Specification Table for End Semester Theory Assessment (ETA): Questions may be designed based on the higher taxonomy level of cognitive domain.

COs	Relevant Unit Number and Title	Marks
CO1	Unit-1.0 Computer Aided Design and Analysis	14
CO2	Unit-2.0 Geometric Transformations	15
CO3	Unit-3.0 Plane and Space Curves	15
CO4	Unit-4.0 Surfaces and 3D Modeling	14
CO5	Unit-5.0 Data Exchange Formats	12
Total		70

N) **Suggested Instructional/ Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT) based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O) **Major Equipment, Tools and Software for Laboratory and Research Work:**

S. No.	Name of Equipment, Tools and Software	BroadSpecifications	Relevant Experience /Practical Number
1.	Computer system	Processor Intel Core i5, 4 GB RAM, 15 GB free disk space	All
2.	Design and development tool	SolidWorks, NX CAD, MATLAB	All

P) **Suggested Learning Resources:**

    a. **Books**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Mathematical Elements for Computer Graphics	David F. Rogers and J. Alan Adams	Tata McGraw-Hill Edition, ISBN: 978-0070535305
2.	CAD/CAM: Theory and Practice	Ibrahim Zeid, R Sivasubramanian	Tata McGraw-Hill, ISBN: 978-0070151345
3.	CAD/CAM Principles and Applications	P. N. Rao	Tata McGraw-Hill, ISBN: 978-0070681934
4.	Geometric Modeling	Michael E. Mortenson	John Wiley, ISBN: 978-0471129578
5.	Computer-Aided Engineering Design	Anupam Saxena, Birendra Sahay	Springer, ISBN: 978-1402025556

    b. **Online Educational Resources:**

        1) https://nptel.ac.in/courses/112104031
        2) https://archive.nptel.ac.in/courses/112/102/112102101/

Q) **Course Curriculum Developer**

S. No.	Name and Designation	E-mail Address
1.	Prof. Ravi Kumar Gupta	rkgupta@nitttrbpl.ac.in

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A)	**Course Title:** Industrial Automation	
B)	**Course Code:** CAMA02	
C)	**Pre-requisite Course (s):**	

D)   Rationale: This course in Industrial Automation is designed to meet the burgeoning demand for skilled professionals capable of navigating and advancing within today's highly automated industries. As industries increasingly automate their processes to improve efficiency, quality, and safety, there is a growing demand for engineers who can design, implement, and manage sophisticated automation systems. This course aims to bridge the gap between theoretical understanding and practical application, preparing students to tackle real-world challenges through hands-on training with sensors, actuators, and advanced control systems. By integrating emerging technologies like AI and IoT, the program ensures graduates are not only proficient in current industry standards but also capable of driving innovation in smart manufacturing and Industry 4.0 initiatives. Through a blend of theoretical coursework, practical labs, industry insights, and project work, the course equips students with the expertise needed to excel in careers as automation engineers and technology leaders poised to shape the future of industrial automation.

E)   Course Outcomes (COs): After the completion of the course, learners are expected to ensure the accomplishment and attainment of following industry aligned course learning outcomes

Course Outcomes (COs)	Course Outcome Statements
CAMA02.CO1	Apply principles and strategies of automation.
CAMA02.CO2	Use different types of sensors and input devices.
CAMA02.CO3	Use different types of actuators and output devices.
CAMA02.CO4	Analyse basic and advanced control systems
CAMA02.CO5	Use SCADA for supervisory control and for acquiring data from the field.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)				
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/document.	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	**PO-4** An ability to use modern tools and techniques related to CAD, Manufacturing and Automation.	**PO-5** An ability to apply optimization techniques to provide competitive optimal solution to the real world of work problems.
CAMA02.CO1	2	-	2	-	-
CAMA02.CO2	3	2	2	2	-
CAMA02.CO3	3	2	2	2	-
CAMA02.CO4	3	2	2	2	-
CAMA02.CO5	3	2	2	2	-

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA02	PCC	Industrial Automation	45	15	45	15	120	04	30	70	20	-	20	30	170

H) **Course Curriculum Detailing:** For the attainment of course outcomes, the students are expected to perform/ undergo various activities in the classroom, laboratories/ workshops/ term work, and self-learning/ field sessions. As per the requirements of NEP: 2020, unique features like Green skills, Multidisciplinary Aspects, Societal Connect, IKS, and Renewable Energy are integrated appropriately.

I) Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)

TSO.1a Describe Industry 4.0 and its component
TSO.1b Explain different types of automation systems
TSO.1c Explain the type of automation used in the given industry.
TSO.1d Analyze the working of industrial processes and products for automation.
TSO.1e Select criteria for factory automation and processes automation for the given industry.
TSO.1f Describe IOT, IIOT and role of robot's with respect to automation.
TSO.1g Prepare the layout of transfer lines in the given manufacturing situation.
TSO.1h Select principles and strategies for automation for the given situation.
TSO.1i Explain the role of Artificial Intelligence and Machine Learning in modern industrial automation systems
TSO.1j Explain the procedure for integrating AI and ML into automation to enhance performance and adaptability.
	Unit-1.0 Introduction to Industrial Automation
	
	1.1 Introduction to Industry 4.0 and its components
	
	1.2 Need of automation in industries, Principles and strategies of automation, factory automation, process automation
	
	1.3 Basic elements of an automated system, Structure of Industrial Automation Advanced automation functions, Levels of automations
	
	1.4 Industrial control Systems- Process and Discrete system
	
	1.5 Types of automation system: Fixed, Programmable, Flexible, Integrated Automation and its application
	
	1.6 Different systems used for Industrial automation: PLC, HMI, SCADA, DCS, Drives.
	
	1.7 Introduction to Internet of Things (IoT) and Industrial Internet of Things (IIOT) and its application in Automation.
	
	1.8 Role of robots in automation and its components.
	
	1.9 Fundamentals of automated production lines or transfer lines and its applications.
	
	1.10 Introduction to AI and ML in Industrial Automation
	  • Definition and difference between AI and ML
	  • Application areas in automation
	  • Integration with industrial systems
	
	1.11 Benefits and challenges in adoption
		CO1

TSO.2a Explain commonly used input field devices in PLC installations along with their symbols. TSO.2b Describe the function of various switches used in PLC installations with their symbol. TSO.2c Explain the various digital input devices used in a PLC installation. TSO.2d Describe the working of different types of discrete sensors with their applications.	**Unit 2.0 – Sensors and Input field devices** 2.1 Analog input devices-Electromagnetic relays, Contactors, Motor starters, 2.2 Manually operated Switches 2.3 Toggle switch, pushbutton switch, knife switch and selector switches 2.4 Mechanically operated switches Limit switch, Temperature switch	CO2

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO.2e Describe the working of different types of advanced sensors with their applications. TSO.2f Explain the procedure for interfacing sensor systems to IIoT platforms. TSO.2g Select Sensors as per the given requirement	(Thermostat), Pressure switch, Level switch and their symbols 2.5 Discrete/Digital Input devices Construction and working of Sensors - Proximity sensors- Inductive, Capacitive, Optical and ultrasonic 2.6 Advanced sensors- Construction and working of • Temperature sensors- Thermistor, Thermocouple and Resistance temperature Detector (RTD) • Liquid level sensor -Capacitive and Ultrasonic • Force -Strain/Weight sensors • Flow sensors – turbine flow sensor • Pressure sensors- Linear Variable Differential Transformer (LVDT) • Inclination sensor -Inclinometer • Acceleration sensor- Accelerometer • Angular and linear position sensor 2.10 Role of AI/ML in sensor data interpretation • Smart sensors and adaptive sensing	
TSO.3a Describe the function of various output devices used in PLC installations with their symbol TSO.3b Describe the construction and working of the given actuator. TSO.3c Explain the basic principle of operation of the given pneumatic and hydraulic actuator. TSO.3d Differentiate between hydraulic and pneumatic actuators TSO.3e Explain the basic principle of operation of the given control valve. TSO.3f Develop different hydraulic and pneumatic circuits for simple applications. TSO.3g Select output devices as per the requirement. TSO.3h Explain the role of AI/ML in intelligent actuation and predictive motion control.	**Unit 3.0- Actuators and Output Devices** 3.1 Introduction to actuators 3.2 Classification of actuators 3.3 Mechanical actuators -Translational and rotational motion, kinematic chains, cams, gears, belt and chain drives, bearings 3.4 Hydraulic and Pneumatic actuators- linear and rotary actuators, single and double acting cylinder, directional, process and pressure control valves 3.5 Electrical actuators 3.6 Electromechanical actuators 3.7 Construction, working and application of Stepper motors, AC/DC Servo motors, BLDC Motor (Very brief) 3.8 Electrohydraulic actuators-Solenoid valve 3.9 Thermal actuators and Magnetic actuators 3.10 Selection of actuators 3.11 Other Output devices- Indicators, Alarms Pilot Lights, Buzzers, Valves, Motor starters, Horns and alarms, Stack lights Control relays, Pumps and Fans.	CO3

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	3.12 Role of AI/ML in Intelligent Actuation and Output Devices, AI-based motion control.	
TSO 4a. Interpret control system block diagrams and signal flow. *TSO 4b.* Describe the basic process control system with the help of a block diagram *TSO 4c.* Explain the types of control available in a process control *TSO 4d.* Describe the different types of controllers in a closed loop system with the help of a block diagram *TSO 4e.* Describe the construction, working and application of the given control system components. *TSO 4f.* Explain different types of control strategies (on- off, feedforward, PID). *TSO 4g.* Explain modern AI control techniques. *TSO 4h.* Explain ML models for predictive and adaptive control	**Unit 4– Control System** 4.1 Block diagram of a basic control system 4.2 Open and closed loop system, their transfer function 4.3 First order and second order system and their output response and parameters 4.4 Types of control – On-off, Feed forward, Open loop and closed loop control and Transfer function 4.5 Controllers in closed loop control 4.6 Proportional Controller (P Controller) 4.7 Integral Controller (I Controller) 4.8 Derivative controller (D- Controller) 4.9 P-I Controller 4.10 P-D Controller 4.11 PID Controller 4.12. AI/ML in Modern Control Systems 4.13 AI vs. traditional control logic 4.14 ML models for predictive and adaptive control	CO4
TSO 5a. Describe SCADA Architecture *TSO 5b.* Explain the procedure of Interfacing the given PLC with SCADA system using the given Open Platform Communications (OPC). *TSO 5c.* Describe the steps to develop a simple SCADA screen for the given industrial application. *TSO 5d.* Describe the procedure to maintain the SCADA based PLC system for the given application. *TSO 5e.* Explain the procedure of Integrating cloud-based ML platforms to enhance SCADA with smart visualization and decision-making	**Unit-5.0 SCADA and DCS** 5.1 Introduction, need, benefits and typical applications of SCADA (Supervisory Control and Data Acquisition) and DCS (Distributed Control System) 5.2 SCADA Architecture - Remote Terminal Units (RTUs), Master Terminal Units, Various SCADA editors, Communication protocols for SCADA 5.3 Comparison of SCADA with DCS 5.4 Interfacing SCADA system with PLC-Typical connection diagram, Object Linking and Embedding for Process Control (OPC) architecture 5.5 Creating SCADA Screen HMI for simple object, Steps for linking SCADA object (defining Tags and items, creating trends etc.,) with PLC ladder program using OPC, configuring simple applications using SCADA: Traffic light control, water distribution, pipeline control, Power generation, transmission	CO5

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	and distribution etc. 5.6 Procedure to maintain the SCADA based PLC system. 5.7 Role of AI/ML in Enhancing SCADA and DCS Systems, AI-driven predictive maintenance and fault detection, Smart analytics and visualization, Use of cloud-based ML platforms with SCADA/DCS	

J) Suggested Laboratory Experiences

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number(s)
LSO 1.1 Identify various building blocks and major automation components in the given robotic system LSO 1.2 Identify various building blocks and major automation components in a given electrical drives LSO 1.3 Plan the steps to automate the given system.	1.	• Identify major automation components in the given system • Analyze given traditional machine in the laboratory and identify the steps and components required to automate it.	CO1
LSO 2.1 Test the response of digital inductive proximity sensor by detecting different types of materials LSO 2.2 Test the response of digital capacitive proximity sensors by detecting different materials LSO 2.3 Test the response of digital optical proximity sensor by detecting different materials LSO 2.4 Test the response of digital ultrasonic proximity sensors by detecting different materials LSO 2.5 Use thermistor to measure temperature of the given material LSO 2.6 Use Thermocouple to measure the temperature of the given liquid and plot the output voltage versus temperature LSO 2.7 Use RTD to control the temperature of an oven LSO 2.8 Use flow sensors to measure the flow of a given liquid or gas LSO 2.9 Use pressure sensors to measure the pressure of a liquid or gas LSO 2.10 Use load cell for the measurement of mechanical force/weight.	2	• Test different types of digital inductive proximity sensor. • Test different types of digital capacitive proximity sensor • Test different types of digital optical proximity sensor • Test different types of digital ultrasonic proximity sensor • Use different types of thermistor to measure temperature. • Use thermocouple to measure temperature. • Use different types of RTDs for temperature measurement • Use different types of flow sensors for flow measurement • Use different types of pressure sensors for pressure measurement • Use different types of load cell force/weight measurement	CO2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number(s)
LSO 3.1 Design pneumatic circuit for lift control LSO 3.2 Design a pneumatic system that rivets the pockets on jeans LSO 3.3 Design pneumatic circuit to open and close the security gate and control the speed. LSO 3.4 Design a circuit for speed control of hydraulic motor meter out circuit by using 4/3 DC valve. LSO 3.5 Design a circuit for speed control of double acting cylinder meter in by using 4/2 dc solenoid valve. LSO 3.6 Design a circuit for speed control of double acting cylinder meter out by using 4/3 solenoid valve LSO 3.7 Operate hydraulic motor by varying the load, flow rate and pressure and note the changes in speed and torque and plot performance curves. LSO 3.8 Operate stepper motor and control the motor by changing number of steps, the direction of rotation and speed. LSO 3.9 Speed Control of DC Drives using PID Controller Interfacing Unit LSO 3.10 Determine optimal motor speed based on load and temperature	3	• Design and actuate pneumatic/ hydraulic circuit for the given situation • Operate hydraulic motor • Operate stepper motor • Speed Control of DC Drives • AI-Controlled Speed Adjustment of a Motor	CO3
LSO 4.1 Test the output response of an open loop, closed loop and feed forward path LSO 4.2 Test the output response of a first order system for a step input using a CRO LSO 4.3 Test the response of a second order system for a step input using CRO and also mark various parameters LSO 4.4 Test the output response of an on-off and Proportional control-based level control system. LSO 4.5 Test the output response pf a P+I+D based level control system.	4	• Analyze the given system to study open loop, closed loop and feed • forward path. • Analyze the given first order system and its transfer function and output response • Analyze the given second order system and its transfer function and output response • Analyze the given water level control system with on-off, • Proportional control. • Analyze the given water level control system with P+I+D control.	CO4
LSO 5.1 Download any open source SCADA software and install the same LSO 5.2 Identify the building blocks of a given typical SCADA system LSO 5.3 Interpret the available components in symbol factory of SCADA software LSO 5.4 Create simple SCADA HMI	5	• Develop simple SCADA HMI applications using any one open source SCADA software • Use SCADA-collected sensor data (e.g., from a motor) to predict maintenance needs	CO5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number(s)
applications and apply dynamic properties (Select any Three from the given list • Turn on and off a tube light using a switch • Move the object, fill the object using slider and meter reading • Apply orientation property to a fan and control its direction using a slider. • Move a square object horizontally first, then vertically and again horizontally by applying visibility property LSO 5.5 Predictive Maintenance from SCADA Data using ML			

K)   Suggested Research Based Problems

   i.   Develop a simple automatic water level controller using a magnetic float switch.
  ii.   Develop a simple automatic door system using an optical sensor and a linear actuator.
 iii.   Troubleshoot the faulty equipment available in the automation laboratory
  iv.   Select one industry and analyze the process and propose the automation strategies that can be used for automation.

   v.   Develop a smart irrigation device to detect the change in moisture level in the soil and controls the flow of water accordingly with a DC pump.
  vi.   Develop an Automation system to open and close the door in the shop
 vii.   Develop a line following robot with RFID sensor for supplying materials and automating workflow.
viii.   Develop smart street light controlling mechanism.

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L)   Suggested Term Work (TW):

a.   Assignment(s):

   • State three advantages of using programmed PLC timer over mechanical timing relay.
   • Prepare a list of open source PLC software and SCADA software
   • Identify the practical applications of PLC systems and SCADA systems and prepare a detailed report.
   • Compare the PLC and PC with regard to:
     - Physical hardware differences
     - Operating environment

- Method of programming
- Execution of program

b. Seminar Topics:

- Prepare a classification chart of different types of actuators.
- Differentiate between Nano and micro actuators.

M) Suggested Specification Table for End Semester Theory Assessment (ETA): Questions may be designed based on the higher taxonomy level of cognitive domain.

COs	Relevant Unit Number and Title	Marks
CO1	Unit-1.0 Introduction to Automation	14
CO2	Unit-2.0 Sensors and Input field devices	14
CO3	Unit-3.0 Actuators and output devices	14
CO4	Unit-4.0 Control system	14
CO5	Unit -5.0 SCADA and DCS	14
Total		**70**

N) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT) based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O) Major Equipment, Tools and Software for Laboratory and Research Work:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experience /Practical Number
1.	Pneumatic, Hydraulic and Sensor trainer kit	Pneumatic trainer Hydraulic trainer Sensor trainer	All
2.	Microprocessor and microcontroller, Robotic kit and SCADA software	Microprocessor and microcontroller trainer kit Pick and place robots Robotic kit SCADA software (reputed make like Allen Bradley, Siemens etc.,) Hydraulic, Pneumatic and sensor software	All

P)   Suggested Learning Resources:

a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Industrial Automation with SCADA: Concepts, Communications and Security	K S Manoj	Notion Press; 1st edition, 2019 ISBN-13: 978-1684668281
2.	Introduction to Industrial Automation	Stamatios Manesis, George Nikolakopoulos	CRC Press, 1st edition,2020 ISBN 9780367571832
3.	Industrial Automation Using PLC SCADA & DCS	R.G. Jamkar	Global Education Limited, 2018, ISBN-13: 978-8193579954
4.	Industrial automation and Process control	Stenerson Jon	PHI Learning, New Delhi, 2003, ISBN: 9780130618900
5.	Control System	Nagrath & Gopal	New Age International Pvt Ltd, ISBN: 9789386070111
6.	Industrial automation and Process control	Stenerson Jon	PHI Learning, New Delhi, 2003, ISBN: 9780130618900
7.	Programmable Logic Controller	Jadhav, V. R.	Khanna publishers, New Delhi, 2017, ISBN: 9788174092281
8.	Programmable Logic Controllers and Industrial Automation - An introduction,	Mitra, Madhuchandra; Sengupta, Samarjit	Penram International Publication, 2015, ISBN: 9788187972174
9.	Supervisory Control and Data Acquisition	Boyar, S. A.	ISA Publication, USA, ISBN: 978-1936007097
10.	Practical SCADA for industry	Bailey David, Wright Edwin	Newnes, UK 2003, ISBN:0750658053

b) Online Educational Resources (OER):

1) Process Automation Control- online Tutorial: www.pacontrol.com
2) PLC product: www.seimens.com
3) www.ab.rockwellautomation.com
4) PLC product: www.abb.co.in
5) Different product of PLC and Peripherals, Smart Tile CPU Board, All in one lighting energy controller, Classic PLC www.triplc.com
6) Simulation software: http://plc-training-rslogix-simulator.soft32.com/free-download/
7) Simulator: www.plcsimulator.net/
8) https://www.youtube.com/watch?v=y2eWdLk0-Ho&list=PLln3BHg93SQ_X5rPjqP8gLLxQnNSMHuj-
9) https://www.youtube.com/watch?v=86CrhxgAKTw

Q)   Course Curriculum Developer

S. No.	Name and Designation	E-mail Address
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National Institute of Technical Teachers' Training and Research, Bhopal
(Deemed to be University under Distinct Category), MOE, GOI

17

A)	**Course Title:** Advanced Engineering Materials
B)	**Course Code:** CAMA03
C)	**Pre- requisite Course (s):**

D)   Rationale: Conventional materials used in design and manufacturing of products sometimes lack in the desired properties. Hence, knowledge about advanced engineering materials like non-metal polymers and their composites will help designers to choose those materials for applications under consideration. Composite materials can be tailor-made to get the desired properties for a given application. Knowledge of manufacturing processes for materials is required for manufacturing the products. The learners will be able choose appropriate constituent materials, optimize configuration, fabricate the composite materials and test their properties.

E)   Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following industry-expected course outcomes by the learners

Course Outcomes (COs)	Course Outcome Statements
CAMA03.CO1	Select appropriate material for a given industrial application
CAMA03.CO2	Design a composite material with the optimum configuration of constituents
CAMA03.CO3	Identify a suitable processing technique for the designed composite material
CAMA03.CO4	Fabricate the designed composite material with dentified processing technique
CAMA03.CO5	Analysis of macromechanical properties numerically and experimentally

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)				
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/document.	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	**PO-4** An ability to use modern tools and techniques related to CAD, Manufacturing, and Automation	**PO-5** An ability to apply optimization techniques to provide competitive optimal solution to the real world of work problems
CAMA03.CO1	3	3	3	2	3
CAMA03.CO2	3	2	2	3	-
CAMA03.CO3	3	2	-	2	3
CAMA03.CO4	3	3	2	3	2
CAMA03.CO5	3	3	3	3	-

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) Teaching &Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA03	PCC	Advanced Engineering Materials	45	15	45	15	120	04	30	70	20	-	20	30	170

H) Course Curriculum Detailing: For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP: 2020, unique features like Green skills, Multidisciplinary Aspects, Societal Connect, IKS, and Renewable Energy are integrated appropriately.

I) **Theory Session Outcomes (TSOs) and Units:**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Classify the Materials TSO 1b. Choose Appropriate Material for a given application TSO 1c. Select constituent materials for composites TSO 1d. Identify properties of constituent materials	**Unit-1.0 Introduction** 1.1 Classification of Materials 1.2 Limitations of conventional materials 1.3 Advanced Engineering Materials-Composites 1.4 Types of Composite Materials 1.5 Constituent Materials 1.6 Properties of Constituent Materials	CO1
TSO 2a. Identify the variables of Composite Design TSO 2b. Identify the constraints in designing the composite TSO 2c. Identify the Objectives of the problem TSO 2d. Formulation of a Design Optimization Problem TSO 2e. Select appropriate optimization method	**Unit-2.0 Design of Composite Materials** 2.1 Problem statement for a given application 2.2 Identification of variables 2.3 Identification of constraints 2.4 Identification of objectives 2.5 Defining the range of variables 2.6 Formulation of the Design Optimization Problem 2.7 Selection of Optimization Technique	CO2
TSO 3a. Use the Diffusion bonding technique for making MMCs TSO 3b. Use the Infiltration technique for MMCs TSO 3c. Apply the Hand Layup technique for FRPs TSO 3d. Apply the Vacuum bagging technique	**Unit-3.0 Fabrication of composites** 3.1 Fabrication Methods of MMCs 3.2 Diffusion bonding, Infiltration technique 3.3 Fabrication Methods of FRPs 3.4 Hand Layup Technique 3.5 Vacuum bagging technique	CO3
TSO 4a. Apply Cutting, machining, and drilling processes TSO 4b. Use water jet machining and Electric discharge machining TSO 4c. Repair the composites	**Unit 4.0: Processing of Composites** 4.1 Conventional Cutting 4.2 Machining and drilling 4.3 Water jet machining 4.4 Electric discharge machining 4.5 Damage and repair of composites	CO4
TSO 5a. Apply Hooke's Law for a 2-D lamina TSO 5b. Relate Compliance and Stiffness Matrix to Engineering Elastic Constants TSO 5c. Choose an appropriate theory of failure	**Unit 5.0: Macromechanical Analysis** 5.1 Hooke's Law for Different Types of Materials 5.2 Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress assumption 5.3 Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants 5.4 Theories of failure	CO5

J) Suggested Laboratory Experiences:

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant COs Number (s)
LSO 1.1 Formulate a design optimization problem for the given constituent materials of the CFRP composite *LSO 1.2* Choose an appropriate optimization method *LSO 1.3* Optimize the configuration of CFRP	1.	Design of CFRP composite with optimum configuration	CO-1, CO-2
LSO 2.1 Formulate a design optimization problem for the given constituent materials of the GFRP composite LSO 2.2 Choose an appropriate optimization method LSO 2.3 Optimize the configuration of GFRP	2.	Design of GFRP composite with optimum configuration	CO-1, CO-2
LSO 3.1 Organize the set-up for hand layup LSO 3.2 Arrange the constituent materials of the CFRP composite LSO 3.3 Fabricate CFRP by hand Lay-up technique	3.	Fabrication of CFRP composite with hand Lay-up technique	CO-3, CO-4
LSO 4.1 Organize the set-up for hand layup LSO 4.2 Arrange constituent materials for the GFRP composite LSO 4.3 Fabricate GFRP with hand Lay-up technique	4.	Fabrication of GFRP composite with hand Lay-up technique	CO-1, CO-2
LSO 5.1 Prepare the vacuum bagging setup LSO 5.2 Fabricate CFRP with the Vacuum bagging technique	5.	Fabrication of CFRP with the Vacuum bagging technique	CO-3, CO-4
LSO 6.1 Prepare the vacuum bagging setup LSO 6.2 Fabricate GFRP with the Vacuum bagging technique	6.	Fabrication of GFRP with the Vacuum bagging technique	CO-3, CO-4
LSO 7.1 Make the additive manufacturing machine ready for fabrication LSO 7.2 Fabricate FRP with Additive Manufacturing technique	7.	Fabrication of FRP with the Additive Manufacturing technique	CO-3, CO-4
LSO 8.1 Preparation of the testing machine for the determination of Hooke's law LSO 8.2 Verify Hooke's Law and determine Young's Modulus for FRP	8.	Verification of Hooke's Law and Determination of Young's Modulus for FRP	CO-5
LSO 9.1 Preparation of the testing machine for the determination of Tensile strength LSO 9.2 Determine Tensile Strength	9.	Determination of Tensile Strength of CFRP	CO-5
LSO 10.1 Preparation of the testing machine for the determination of Compressive Strength LSO 10.2 Determine Compressive Strength	10.	Determination of Compressive Strength of CFRP	CO-5

K) Suggested Research Based Problems:

i.   Identify some household items made of metal. Justify the use of FRP material for these items in place of metal.
ii. Compare the effect of GFRP and CFRP on carbon footprints.
iii. Trucks are subjected to impact from the front side. Design FUPD of a truck made of FRCP composite with optimum parameters.

L) Suggested Term Work (TW)

   a. Assignment(s):

   * The box has several gears on multiple shafts. Find the Optimum material configuration for the gearbox for the reduction of speed in a ratio of 1:10
   * Fabrication of an automotive dashboard with FRP material

   b. Seminar Topics:

   * Modern Engineering Materials
   * Materials for Design and Manufacturing

M) Suggested Specification Table for End Semester Theory Assessment (ETA): Questions may be designed based on the higher taxonomy level of the cognitive domain.

COs	Relevant Unit Number	Marks
CO1	Unit 1.0 Introduction to Engineering Materials	10
CO2	Unit 2.0 Design of Composite Materials	14
CO3	Unit 3.0 Fabrication of composites	15
CO4	Unit 4.0 Processing of Composites	15
CO5	Unit 5.0 Macromechanical analysis	16
Total		**70**

N) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT) based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O)   Major Equipment, Tools and Software for Laboratory and Research Work:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experience /Practical Number
1.	Computer systems	Processor Intel Core i9, 64 GB RAM, 64 bit OS, Graphic card 64GB, Storage 2.75 TB	1, 2
2.	Matlab	Matlab Release R2024b	1,2
3.	Hand lay-up processing of Composites	Reinforcement fibre sheets, Epoxy	3,4
4.	SLA 3D printer	Standalone Ultrafast Industrial 3D prnter	5.6,7
5.	UTM HIECO, Simcentre 3D	Load upto 2 KN, Modeling and Optimization Module	8,9,10

P)   Suggested Learning Resources:

  a) Books

S.No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Composite Science and Engineering	K. K. Chawla	Springer Verlag, 1998, 3rd Ed., ISBN-13. 978-0387743646
2.	Fiber Reinforced Composites	P. K. Mallick	Marcel Dekker, Inc, 3rd Ed., ISBN 9780429122064
3.	Mechanics of Composite Materials	Autar K. Kaw	SECOND EDITION, 2006
4.	Mechanics of Composite Materials	Robert M. Jones	McGraw-Hill Kogakusha Ltd. 1998
5.	Optimization for Engineering Design	Kalyanmoy Deb	2nd Edition, Prentice Hall of India, ISBN 9788120346789

  b) Online Educational Resources:

   1) nptel.ac.in/courses/112104168/, nptel.ac.in/courses/101104010/
   2) https://nptel.ac.in/courses/112/104/112104229/
   3) nptel.ac.in/courses/.../IISc.../Composite%20Materials/New_index1.html

Q)   Course Curriculum Developer

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A)	**Course Title:** Basics of Artificial Intelligence and Machine Learning
B)	**Course Code:** CSEB05
C)	**Pre- requisite (s):**

D)   Rationale: Artificial Intelligence and Machine Learning are no longer confined to computer science; they are transformative technologies impacting every engineering discipline. From optimizing civil infrastructure designs, predicting material failures in mechanical systems, enhancing power grid efficiency in electrical engineering, to developing intelligent control systems, AI/ML offers unparalleled tools for problem-solving, efficiency, and innovation.

Therefore, this course is important for all disciplines. This course will equip learners with foundational knowledge in data-driven decision-making, predictive analytics, and automation. Regardless of their specialization, the comprehension of AI/ML will enable them to leverage these technologies to create smarter products, optimize processes, interpret vast datasets, and remain competitive in a rapidly evolving AI-driven industrial landscape.

E)   Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
CSEB05.CO1	Develop Python programs for solving mathematical problems.
CSEB05.CO2	Manipulate Sequence data types in Python
CSEB05.CO3	Analyse the data using Python Libraries, modules, and Packages
CSEB05.CO4	Apply various Machine learning paradigms.
CSEB05.CO5	Evaluate the performance of the prediction model after creating it.
CSEB05.CO6	Analyse data using various tools for AI & ML Applications.

F) **Suggested Course Articulation Matrix (CAM):** (To be prepared by the curriculum development committee of the respective programme)

G) **Teaching & Learning and Assessment Scheme:**

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CSEB05	PCC	Basics of Artificial Intelligence and Machine Learning	30	15	45	30	120	04	30	70	20	-	20	30	170

H) **Course Curriculum Detailing:** For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

I) **Theory Session Outcomes (TSOs) and Units:**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Differentiate between Procedure-Oriented and Object-Oriented Programming approaches with examples.	**Unit-1.0 Basics of Python Programming** 1.1 Procedure oriented vs. Object-Oriented approach of programming	**CO1**
TSO 1b. Explain the concept of Lvalue and Rvalue	1.2 Python character set, Python tokens, variables, concept of Lvalue and Rvalue, use of comments.	
TSO 1c. Write Python program using various data types and operators	1.3 Data types: number (integer, floating point, complex), Boolean, sequence (string, list, tuple), none, mapping (dictionary), mutable and immutable data types	
TSO 1d. Write Python program using decision-making statements.	1.4 Operators: arithmetic operators, relational operators, logical operators, assignment	
TSO 1e. Write Python Program using loop structure to solve iterative problems.	operator, augmented assignment operators. Expressions, statements, type conversion & input/output: precedence of operators, expressions, and evaluation of expressions.	

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	1.5 Conditional statements: simple if statement, if-else statement, if-elif-else statement 1.6 Iterative statements: while loop, for loop, range function, break and continue statements, nested loops	
TSO 2a. Explain the procedure to perform the various operations on a string using string operators and methods. *TSO 2b.* Explain the procedure to perform various operations on a List using list operators and methods *TSO 2c.* Explain the procedure to perform various operations on tuples using tuple operators and methods *TSO 2d.* Explain the procedure to perform various operations on a set using set methods *TSO 2e.* Explain the procedure to perform various operations on a dictionary using dictionary methods. *TSO 2f.* Explain the procedure to create and use user-defined functions to implement a modular programming approach. *TSO 2g.* Explain the working of the scopes of variables.	**Unit 2.0: Sequence data types, Functions.** 2.1 String: indexing, string operations (concatenation, repetition, membership & slicing), traversing a string using loops, and built-in functions. 2.2 Lists: introduction, indexing, list operations: concatenation, repetition, membership & slicing, traversing a list, built-in list functions, linear search on a list of numbers, and counting the frequency of elements in a list 2.3 Tuples: Creating, initializing, accessing elements, tuple assignment, performing operations on tuples, tuple methods and built-in functions, nested tuples 2.4 Set: Creating sets, traversing, adding, removing data in a set, performing set operations like join, Union, intersection, difference 2.5 Dictionary: accessing items in a dictionary using keys, mutability of dictionary: adding a new item, modifying an existing item, built-in dictionary functions. 2.6 Functions: types of function (built-in functions, functions defined in module, user-defined functions), creating user user-defined function, arguments and parameters, default parameters, positional parameters, Lambda functions, returning value, scope of a variable: global scope, local scope	**CO2**
TSO 3a. Write simple Python programs with an object-oriented approach *TSO 3b.* Explain the workflow to use the constructors and destructors appropriately in a Python program *TSO 3c.* Write the program to implement the given type of inheritance in Python. *TSO 3d.* Explain the procedure to implement the concept of Polymorphism in Python *TSO 3e.* Write Python programs for	**Unit-3.0 OOPS, Data Analysis using Modules and Packages** 3.1 Object-oriented programming concepts and approach, Abstraction, encapsulation, class, object, class method vs static method in Python, class and static variable, constructor and destructors in Python. 3.2 Inheritance: single, multiple, multilevel, hierarchical inheritances	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
exception handling in Python *TSO 3f.* Differentiate between different modes of file opening. *TSO 3g.* Explain the procedure to perform read, write, and Append operations in files *TSO 3h.* Explain the procedure to import and use Python modules, libraries, and Packages. *TSO 3i.* Write the procedure to apply the Pandas data structure for data analysis *TSO 3j.* Illustrate the process of using Pandas to perform various operations and functions on series. *TSO 3k.* Explain the procedure to perform the various operations in a Data Frame's columns and rows *TSO 3l.* Write a program to read and write on CSV, XLS, and Text data files *TSO 3m.* Write the procedure to use the various data cleaning operations and prepare data.	3.3 Polymorphism: Polymorphism with class method, polymorphism with inheritance, method overriding, and overloading. 3.4 Exception Handling: syntax errors, exceptions, need for exception handling, user-defined exceptions, raising exceptions, handling exceptions, catching exceptions, Try - except - else clause, Try - finally clause, recovering and continuing with finally, built-in exception classes. 3.5 File Handling: text file and binary file, file types, open and close files, reading and writing text files, reading and writing binary files, file access modes 3.6 Modules and Packages: Importing modules using 'import', Regular Expressions, Exception Handling, PyPI Python Package Index, Pip Python package manager, Importing Libraries and Functions 3.7 Key features and methods for summarizing data in Python, Aggregation and Grouping, data visualization. 3.8 Pandas data structures: Series, Declaration, selecting elements, assigning values, Filtering values, operations, mathematical functions, evaluating values, handling missing data, creating series from dictionaries, adding two series. 3.9 Data Frame: Defining, selecting elements, assigning values, membership, deleting a column, and filtering. Index Objects: Indexing, Re-indexing, Dropping, sorting and ranking, Descriptive Statistics 3.10 Data Loading: Reading and Writing CSV, xls, Text Data Files, Data Cleaning and Preparation: Handling missing data, removing duplicates, replacing values, Vectorized String Methods, Hierarchical Indexing, Merging and Combining, Data aggregation and Grouping.	
TSO 4a. Explain the concept of Artificial Intelligence. *TSO 4b.* Differentiate the various learning paradigms. *TSO 4c.* Explain the use of a suitable machine learning algorithm for the given application.	**Unit-4.0 Introduction to AI & ML** 4.1 Overview of AI: Agents, Natural Language Processing & Decision Network 4.2 Learning Paradigms: Supervised, Unsupervised and Reinforcement Learning. 4.3 ML Algorithms: Supervised Learning Algorithms: Linear Regression, Logistic	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 4d. Explain the procedure for validating the machine learning algorithm.	Regression, Random Forest, k-NN, Decision Tree, SVM, ANN, 4.4 Unsupervised Learning Algorithms: k-Means clustering and k-Mode Clustering 4.5 Reinforcement Learning Algorithm: Q-Learning.	
TSO 5a. Explain the process of exploring the various datasets to identify their characteristics and patterns. TSO 5b. Perform the feature scaling for the given dataset. TSO 5c. Perform the feature selection process on the given dataset. TSO 5d. Explain the procedure to create a model using data preprocessing and classification. TSO 5e. Explain the procedure to create multidisciplinary applications.	**Unit-5.0 Model Creation using Python** 5.1 Datasets: Kaggle, UCI Machine Learning Repository 5.2 Data Pre-processing: Feature Scaling and Feature Selection 5.3 Model creation using data pre-processing, Classification through ML algorithms using Python programming. 5.4 Creation of Multidisciplinary Applications	**CO5**
TSO 6a. Explain the role of AI and ML algorithms in decision-making on various applications. TSO 6b. Explain the features of the Weka Tool TSO 6c. Explain the features of the Orange3 Tool TSO 6d. Explain the features of Julia Tool TSO 6e. Differentiate the features of Weka, Orange3, and Julia. TSO 6f. Perform data preprocessing using Weka, Orange3, and Julia AI. TSO 6g. Explain the process of using classifiers for classification in Weka, Orange3, and Julia AI. TSO 6h. Use clustering methods for grouping the given data in Weka, Orange3, and Julia AI.	**Unit 6.0: Applications of AI & ML and Data Analysis Tools** 6.1 Role of AI & ML in Multidisciplinary, Applications 6.2 Introduction to Weka, Orange3, and Julius AI 6.3 Data pre-processing: Data cleaning, Removal of Stop words, Removal of Null values using Tools such as Weka, Orange3, and Julius AI 6.4 Data Visualization: Bar Chart, Pie Chart, Line Chart, Plot, etc. in Weka, Orange3, and Julius AI. 6.5 Classification through Weka, Orange3, and Julius AI 6.6 Regression through Weka, Orange3, and Julius AI 6.7 Clustering Process using Weka, Orange3, and Julius AI	**CO6**

J)   Suggested Laboratory experiences:

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number (s)
LSO 1.1. Implement conditional statements in Python.	1.	Write Python programs to demonstrate the use of the following conditional statements:	CO1

Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment Titles	Relevant CO Number (s)
			a. If statements b. If-else statements, if-elif-else statements	
LSO 2.1.	Implement Loop statements in Python to solve iterative problems.	2.	Write Python programs to demonstrate the use of the following loop statements: a) While loop b) for loop c) Use of range function, break, continue	CO1
LSO 3.1.	Manipulate given Sequence data types in Python	3.	Write and execute Python Programs to demonstrate various operations on the following sequence data types: a) String b) List	CO2
			Write and execute Python Programs to demonstrate various operations on the following sequence data types: a) Tuple b) Set, c) Dictionary	CO2
LSO 5.1.	Create user-defined functions in Python	4.	Write and execute Python Programs to demonstrate creating and calling User-defined functions	CO2
LSO 5.1.	Use NumPy and Pandas built-in functions	5.	Consider a dataset, and execute the following functions to analyze the dataset. a) Read, head, tail & arithmetic functions b) Loc (Location), iloc (Integer Location) c) Sort, Numpy with Arrays.	CO3
LSO 6.1	Use Python modules.	6.	Conduct a statistical learning process using the Chi-Square test by considering the parametric and Non-parametric tests.	CO3
LSO 7.1. LSO 7.2.	Visualize the given data in various dimensions. Summarize the data according to the dataset's features.	7.	a) Demonstrate the data visualization of the given data. b) Summarize the data with respect to the different attributes of the given salary dataset.	CO3
LSO 8.1.	Apply Linear Regression and Multiple Linear Regression for predictive analysis.	8.	a) Perform the predictive analysis using Multiple Linear Regression. b) Perform the predictive analysis using Linear Regression.	CO4

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number (s)
LSO 8.2. Evaluate the Linear and Multiple Linear Regression models with respect to the standard evaluation metrics.		c) Compare the performance of the Multiple Linear Regression and Linear Regression with respect to the prediction accuracy and time.	
LSO 9.1. Implement the resampling process and feature selection using Python. *LSO 9.2.* Apply the k-nearest neighbor classifier to perform the predictive analysis. *LSO 9.3.* Evaluate the k-nearest neighbour with respect to the evaluation metrics.	9.	a) Perform the resampling process and feature selection using a suitable ML classifier. b) Perform the predictive analysis using k-Nearest Neighbor by considering the dataset with selected features. c) Evaluate the k-nearest neighbour classifier with respect to the standard evaluation metrics like precision, recall, f-measure and accuracy.	CO3, CO4
LSO 10.1. Solve the MCNFP problem for the optimal solution using Python. *LSO 10.2.* Evaluate the efficiency of the MCNFP in the process of optimization.	10.	Implement the Minimum Cost Network Flow Problem (MCNFP) method to find the new path in a transportation network.	CO3, CO4
LSO 11.1. Implement the stochastic decision tree to predict the risk. *LSO 11.2.* Evaluate the performance of the stochastic decision tree by using the evaluation metrics.	11.	Implement the stochastic decision tree algorithm to analyze the risk. (Prefer your own dataset)	CO3, CO4
LSO 12.1. Predict the future result by analyzing the given data using the Random Forest algorithm. *LSO 12.2.* Evaluate the performance of the classifier with respect to the standard evaluation metrics.	12.	a. Execute the source code of the random forest algorithm implementation for predicting diabetic and heart diseases b. Compare the performance of the random forest with k-nearest neighbor by considering the standard evaluation metrics.	CO3, CO4
LSO 13.1 Predict the future result by analyzing an image dataset using the SVM algorithm. *LSO 13.2* Evaluate the performance of the classifier with respect to the standard evaluation metrics. *LSO 13.3* Compare the performance of the SVM with MLP with respect to the standard evaluation metrics.	13.	a) Implement the support Vector Machine (SVM) algorithm for image classification/ semantic segmentation (choose any dataset) b) Evaluate the algorithm's performance with respect to the standard classifiers. c) Compare the performance of the SVM with the Multi-layer perceptron (MLP) by considering the standard evaluation metrics.	CO3, CO4

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Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number (s)
LSO 14.1 Visualize the given dataset using the Weka Tool. *LSO 14.2* Visualize the given dataset using the Orange3 Tool. *LSO 14.3* Visualize the given dataset using the Julia AI tool.	14.	a) Perform the data visualization using the Weka Tool. b) Perform the data visualization using the Orange3 Tool. c) Perform the data visualization using the Julia AI tool.	CO5, CO6
LSO 15.1 Preprocess the given dataset using the Weka Tool. *LSO 15.2* Preprocess the given dataset using the Orange3 Tool. *LSO 15.3* Preprocess the given dataset using the Julia AI tool.	15.	a) Perform the data preprocessing on the given dataset using the Weka Tool. b) Perform the data preprocessing on the given dataset using the Orange3 Tool. c) Perform the data preprocessing on the given dataset using the Julia AI tool.	CO5, CO6
LSO 16.1 Classify the given dataset using the Weka Tool. *LSO 16.2* Classify the given dataset using the Orange3 Tool. *LSO 16.3* Classify the given dataset using the Julia AI tool.	16.	a) Perform the classification process on the given dataset using the Weka Tool. b) Perform the classification process using the Orange3 Tool. c) Perform the classification process using the Julia AI tool	CO5, CO6

K)   Suggested Research Based Problems

     i.   Demonstrate the performance of the Multilayer Perceptron and Artificial Neural Network over a seizer dataset with respect to the detection accuracy and time.

    ii.   Develop a product recommendation system using a stochastic decision tree algorithm by analyzing a sales dataset. Further, the system needs to recommend the product requirement for the specific year and the required quantity to fulfill the customer needs with satisfaction.

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L)   Suggested Term Work (TW):

a.   Assignment(s):

Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b.   Seminar Topics:

- Python Libraries and Packages used in data analytics
- Comparison of various Data Visualization tools

- Role of predictive analysis in real-time applications

- ML algorithms in Decision Making

- ML algorithms in feature engineering

- Weka Vs Orange3 Vs Julia AI

- Role of AI and ML in Multidisciplinary Research

M) **Suggested Specification Table for End Semester Theory Assessment (ETA):** Questions may be designed based on the higher taxonomy level of cognitive domain.

COs	Relevant Unit Number and Title	Marks
CO1	Unit 1.0 Basics of Python Programming	10
CO2	Unit 2.0 Sequence data types, Functions.	10
CO3	Unit 3.0 OOPS, Data Analysis using Modules and Packages	10
CO4	Unit 4.0 Introduction to AI & ML	15
CO5	Unit 5.0 Model Creation using Python	15
CO6	Unit 6.0 Applications of AI & ML and Data Analysis Tools	10
Total		**70**

N) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies: Different instructional/implementation strategies may be appropriately used in online and offline modes, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O) **Major Equipment, Tools and Software for Laboratory and Research Work:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experience /Practical Number
1.	Computer system	Processor Intel Core i7, 32 GB RAM, 15 GB free disk space	All
2.	Integrated Development and Learning Environment (IDLE)	S/w to be downloaded for Python 3.11.3 or higher	1-13
3.	Anaconda Navigator / Jupyter NoteBook	Server for Software Platform	1-13

National Institute of Technical Teachers' Training and Research, Bhopal
(Deemed to be University under Distinct Category), MOE, GOI

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S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experience /Practical Number
4.	Weka	Software Tool	14,15 & 16
5.	Orange3	Software Tool	14,15 & 16
6.	Julia AI	Software Tool	14,15 & 16

P)   Suggested Learning Resources:

  a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Python for Programmers	Paul Deitel and Harvey Deitel	Pearson Education, 1st Edition, 2021 ISBN-10 : 9353947987 ISBN-13 : 978-9353947989
2.	Artificial Intelligence – A Modern Approach	Stuart Russell and Peter Norvig	Fourth Edition, Pearson Education, 2021. ISBN-10 : 1292401133 ISBN-13 : 978-1292401133
3.	Machine Learning: An Algorithmic Perspective	Stephen Marsland	Chapman & Hall/CRC, 2nd Edition, 2014. ISBN-10 : 1138583405 ISBN-13 : 978-1138583405
4.	Data Analytics and Decision Making	Ali Abdul Hussein	Creative Commons Attribution 4.0 International License, University of Windsor, 2022.
5.	Python Data Analytics	Fabio Nelli	Apress,2015 ISBN: 9781484209585
6.	Python for Data Analysis: Data Wrangling with Pandas, Numpy, and Python	Wes McKinney	O'REILLY, 2017, Second Edition ISBN-10: 1491957662 ISBN-13:78-1491957660

  b) Online Educational Resources (OER):

  1)   https://docs.python.org/3/tutorial/
  2)   https://nptel.ac.in/courses/106106145
  3)   https://www.w3schools.com/python/
  4)   https://www.tutorialspoint.com/python/index.htm
  5)   https://www.w3schools.com/python/pandas/default.asp
  6)   https://pandas.pydata.org/docs/user_guide/10min.html
  7)   http://bedford-computing.co.uk/learning/wp-content/uploads/2015/10/Python-Cookbook-3rd-Edition.pdf

8)   Data Sources:

- https://archive.ics.uci.edu/ml/machine-learning-databases/auto-mpg/
- https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data
- https://www.kaggle.com/arshid/iris-flower-dataset
- https://www.kaggle.com/rohankayan/years-of-experience-and-salary-dataset
- https://www.kaggle.com/datasets/johnsmith88/heart-disease-dataset
- https://www.kaggle.com/datasets/harunshimanto/epileptic-seizure-recognition
- https://www.kaggle.com/datasets/mathchi/diabetes-data-set

Q)   Course Curriculum Development Team

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A)	**Course Title:** Sports, Yoga & Meditation
B)	**Course Code:** NEP01
C)	**Pre- requisite (s):**

D)   Rationale: Sports or Physical Education, Yoga and Meditation is an integral part of a person's overall well-being and is imperative for a healthy mind and body balance. Integrating practical activities throughout the curriculum ensures that students not only gain theoretical knowledge but also develop practical skills, enhance their physical and mental well-being, and cultivate a deeper understanding and appreciation for sports, yoga, and meditation. Practical learning experiences are essential for reinforcing concepts, building competence, and fostering a lifelong commitment to health and wellness practices. It's also plays a major role in reducing level of stress/anxiety and add to the mental toughness. Looking to the ample benefits there is need to inculcate sports, Yoga and meditation as a day to day habit. So, it is necessary that every educational institutes should lay ample emphasis on including sports, yoga and meditation as a necessary part of education.

E)   Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
NEP01.CO1	Select appropriate physical activities to maintain healthy lifestyle.
NEP01.CO2	Apply basic principles and practices of Yoga and meditation for overall growth & development.
NEP01.CO3	Use fitness and wellness techniques for optimal health and wellbeing

F)   Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)		
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/document.	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
NEP01.CO1	2	1	1
NEP01.CO2	2	1	1
NEP01.CO3	2	1	1

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
NEP01	NEP	Sports, Yoga & Meditation	15	-	-	15	30	01	25	-	25	-	-	-	50

H)   Course Curriculum Detailing: For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Describe various sports, their benefits, and basic rules. *TSO 1b.* Explain the importance of physical fitness and basic conditioning exercises. *TSO 1c.* Select sports and exercises for physically challenged as per their need. *TSO 1d.* Explain the components of physical fitness (strength, flexibility, endurance). *TSO 1e.* Demonstrate proficiency in performing warm- up and cool-down routines. *TSO 1f.* Apply basic strength training and flexibility exercises to improve fitness levels.	**Unit-1.0 Introduction to Sports** 1.1 Definition of play, game, sports, exercise, psychology, sports psychology and exercise psychology, psychology and common-sense Overview of popular sports (football, basketball, tennis, etc.) 1.2 Benefits of sports for physical health and teamwork 1.3 Basic rules and equipment of selected sports 1.4 Components of physical fitness (strength, flexibility, endurance) 1.5 Warm-up and cool-down routines 1.6 Introduction to strength training and flexibility exercises 1.7 Adaptation of sports and exercises for physically challenged students in all levels.	**CO1**
TSO 2a. Apply principles and practices of yoga. *TSO 2b.* Explore techniques for mental relaxation and focus. *TSO 2c.* Explain history, philosophy, and principles of yoga. *TSO 2d.* Practice basic yoga asanas (poses) and their benefits. *TSO 2e.* Practice breath control (pranayama) and relaxation techniques effectively. *TSO 2f.* Develop a structured sequence of yoga poses for specific purposes (strength, flexibility, relaxation). *TSO 2g.* Integrate meditation techniques as part of their yoga practice. *TSO 2h.* Describe the benefits of meditation and mindfulness practices. *TSO 2i.* Apply mindfulness techniques to enhance focus, reduce stress, and improve overall well- being. *TSO 2j.* Select yoga and meditation for physically challenged as per their need.	**Unit-2.0 Yoga and Meditation** 2.1 History and philosophy of yoga 2.2 Role of yoga and meditation in purificatory process, in character building, developing concentration, will power and discipline 2.3 Types of yoga practices - asanas, pranayama, meditation 2.4 Basic yoga asanas (poses) and their benefits 2.5 Importance of breath control (pranayama) and relaxation techniques 2.6 Intermediate yoga asanas and their variations 2.7 Sequencing of yoga poses for different purposes (strength, flexibility, relaxation) 2.8 Introduction to meditation techniques 2.9 Benefits of meditation and mindfulness practices 2.10 Techniques: mindfulness meditation, guided visualization, body scan 2.11 Application of mindfulness in daily life and sports performance 2.12 Adaptation of yoga and meditations for physically challenged students in all levels	**CO2**
TSO 3a. Describe the mental aspects of sports and performance. *TSO 3b.* Apply skills learned in sports, yoga,	**Unit-3.0 Sports, Mental Conditioning and Integration** 3.1 Mental preparation techniques for sports	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
and meditation in practical settings *TSO 3c.* Integrate physical fitness, yoga, and mental conditioning into a comprehensive wellness routine. *TSO 3d.* Create and implement personalized fitness and wellness plans based on learned principles.	3.2 Goal setting and visualization 3.3 Overcoming performance anxiety and stress management 3.4 Integration of physical fitness, yoga, and mental conditioning 3.5 Creating personal fitness and wellness routines	

J)   **Suggested Laboratory Experiences:** (Not Applicable)

K)   **Suggested Research Based Problems**

a. Develop nutritional guidelines and programs that result in measurable improvements in athletic performance and recovery times.

b. Develop comprehensive mental health programs that effectively reduce anxiety, depression, and burnout in athletes.

c. Identify yoga practices that results in measurable improvements in mental health outcomes such as reduced stress, anxiety, and depression.

d. Identify and study specific neurobiological changes due to yoga, leading to enhanced mental and physical health.

e. Develop and validate meditation practices that significantly reduce symptoms of anxiety, depression, and PTSD.

f. Investigate group meditation dynamics that result in improved mental health outcomes and increased group cohesion.

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L)   **Suggested Term Work (TW):**

a. **Assignments**: (Seminar Topics/ Visits/ Self- Learning Topics)
Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

- Calculate your Body Composition (BMI) and Cardiovascular Assessment
- Assessment for Muscular Endurance, Muscular Strength,
- Flexibility, Cardio-respiratory Endurance, Body Composition
- Rules and Regulations of different indoor and outdoor games.

  b. **Seminar Topics:**

- Ethics in sports
- Application of principles of yoga in daily life.
- Strategies to Incorporate mindfulness practices into everyday activities

M) **Suggested Specification Table for End Semester Theory Assessment (ETA):** (Not Applicable)

N) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O) **Major Equipment, Tools and Software Research Work:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications
1.	Soccer Ball	Size 5, made of synthetic leather, weight 410-450g
2.	Tennis Racket	Length 27 inches, strung with synthetic gut, weight 280-300g
3.	Badminton racket and net	-
4.	Table tennis racket and net	-
5.	Basketball	Size 7, made of leather, weight 567-650g
6.	Base ball set	-
7.	Cricket bat and ball	-
8.	Hockey sticks and balls	-
9.	Javelin Throw	Length: 2.6 - 2.7 meters (8 ft 6 in - 8 ft 10 in) Weight: 800 grams Material: Metal head with a hollow or solid shaft
10.	Discus Throw	Weight: 2 kg for men, 1 kg for women Diameter: 22 cm for men, 18 cm for women Circle Diameter: 2.5 meters (8.2 ft) Material: Made of metal, smooth surface
11.	Shot Put	Weight: 7.26 kg for men, 4 kg for women Diameter: 110-130 mm (4.3-5.1 inches) for men, 95-110 mm (3.7-4.3 inches) for women Circle Diameter: 2.135 meters (7 ft) Material: Made of steel
12.	Chess, carrom	Chess and carrom set
13.	Resistance Bands	Various resistance levels, latex material
14.	Dumbbells	1-10 lbs, adjustable weights

S. No.	Name of Equipment, Tools and Software	Broad Specifications
15.	Jump Rope	Adjustable length, durable material
16.	Exercise Mat	Non-slip surface, cushioned, 68 x 24 inches
17.	Step Platform	Adjustable height, sturdy, non-slip surface
18.	Hand Weights	1-5 lbs, ergonomic grip
19.	Heart Rate Monitor	Wrist-worn, accurate readings
20.	Fitness Ball	55-75 cm diameter, anti-burst material
21.	Aerobics mats -	• Thickness- approx. 1/4 to 1/2 inch for adequate cushioning • Material- Non-slip PVC, rubber, or foam • Size-minimum 68 x 24 inches and larger sizes • Portability- Lightweight and easy to roll up • Durability- Tear-resistant and easy to clean • Design- Textured surface for better grip • Weight- Lightweight (around 2-3 pounds) for easy transport
22.	Sports Wheelchairs	Customized for different sports, lightweight, adjustable
23.	Adaptive Bicycles	Handcycles, tricycles, recumbent bikes
24.	Modified Dumbbells	Adjustable grips for different hand sizes and strength levels
25.	Adaptive Treadmills	Hand-cranked or wheelchair-accessible treadmills
26.	Prosthetics	High-performance prosthetics for running, swimming, etc.
27.	Adaptive Yoga Mat	1/4-inch-thick, non-slip surface, 68 x 24 inches, extra cushioning for support
28.	Yoga Blocks	4 x 4 x 9 inches and various sizes, made of cork or foam
29.	Yoga Strap	6 feet long, adjustable buckle, Adjustable length, made of nylon
30.	Blanket	72 x 48 inches, made of cotton, lightweight
31.	Water Bottle	500ml capacity, BPA-free plastic, leak-proof
32.	Yoga Bolsters	Soft, supportive, various sizes
33.	Chair Yoga Props	Sturdy chairs with low back, no arms
34.	Meditation Cushion	12 x 12 inches, filled with buckwheat hulls or foam, supportive cushions
35.	Meditation Bench	12 inches wide, 18 inches long, adjustable height, comfortable seating
36.	Meditation Bell	2 inches in diameter, made of brass, produces clear sound
37.	Timer	Digital, with a soft alarm sound, battery-operated
38.	Essential Oil Diffuser	100ml capacity, adjustable mist settings, made of ceramic
39.	Blood pressure equipment	Blood pressure equipment

S. No.	Name of Equipment, Tools and Software	Broad Specifications
40.	Blood sugar equipment	Blood sugar equipment
41.	Massage therapy equipment, Hot and cold therapy equipment, Ultrasound therapy equipment for pain relief.	Massage therapy equipment, Hot and cold therapy equipment, Ultrasound therapy equipment for pain relief.
42.	Safety accessories	Helmet, Mouthguards, Protective Eyewear, Shin Guards, Knee Pads, Elbow Pads,Wrist Guards, Padded Shorts, Safety Harnesses, Life Jackets, etc

P)   Suggested Learning Resources:

   a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Practical Applications in Sports Nutrition	Heather Hedrick Fink, Alan E. Mikesky	Jones & Bartlett Learning (2020) ISBN No: 978-1284181340
2.	ACSM's Guidelines for Exercise Testing and Prescription	Gary Liguori	LWW; (2021) ISBN-13: 978-1975150198
3.	Essentials of Strength Training and Conditioning	Javair Gillett	Human Kinetics, (2021) ISBN-13: 978-1718210868
4.	Practical Applications in Sports Nutrition	Heather Hedrick Fink, Alan E. Mikesky	Jones & Bartlett Learning, (2017) ISBN-13: 978-1284101393
5.	Health Fitness Management	Mike Bates, Mike Spezzano, Guy Danhoff	Human Kinetics, (2019) ISBN-13: 978-1450412230
6.	Yoga for Every Body: A beginner's guide to the practice of yoga postures, breathing exercises and meditation	Luisa Ray, Angus Sutherland	Vital Life Books (2022) ISBN-13: 978-1739737009
7.	Science of Yoga: Understand the Anatomy and Physiology to Perfect Your Practice	Ann Swanson	DK Publisher, (2019) ISBN-13: 978-1465479358
8.	Mudras for Modern Living: 49 inspiring cards to boost your health, enhance your yoga and deepen your meditation Cards	Swami Saradananda	Watkins Publishing (2019) ISBN-13: 978-1786782786
9.	Counselling Skills in Applied Sport Psychology: Learning How to Counsel	Paul McCarthy, Zoe Moffat	Routledge, (2023) ISBN-13: 978-1032592589
10.	Advancements in Mental Skills Training (ISSP Key Issues in Sport and Exercise Psychology)	Maurizio Bertollo, Edson Filho, Peter Terry	Routledge, (2020) ISBN-13: 978-0367111588
11.	The Relaxation and Stress Reduction Workbook	Martha Davis, Elizabeth Robbins, Matthew McKay, Eshelman MSW	A New Harbinger Self-Help Workbook (2019)
12.	Patanjalis Yoga Sutras	Swami Vivekananda	Fingerprint Publishing (2023) Prakash Books India Pvt Ltd, New Delhi ISBN-13: 978-9354407017

b) Online Educational Resources (OER):

1) https://onlinecourses.swayam2.ac.in/aic19_ed28/preview- introduction to Yoga and Applications of Yoga
2) https://onlinecourses.swayam2.ac.in/aic23_ge09/preview- Yoga for Creativity
3) https://onlinecourses.swayam2.ac.in/aic23_ge05/preview- Yoga for concentration
4) https://onlinecourses.swayam2.ac.in/aic23_ge06/preview- yoga for memory development
5) https://onlinecourses.nptel.ac.in/noc21_hs29/preview-Psychology of Stress, Health and Well being
6) https://onlinecourses.swayam2.ac.in/nce19_sc04/preview- Food Nutrition for Healthy Living - Course – Swayam
7) https://www.classcentral.com/course/swayam-fitness-management-17608- Fitness Management from Swayam
8) https://onlinecourses.swayam2.ac.in/nce19_sc04/preview-Food Nutrition for Healthy Living
9) https://onlinecourses.swayam2.ac.in/cec21_ed02/preview Health Education and Recreation
10) https://onlinecourses.swayam2.ac.in/cec22_ed31/preview Sports Administration and Management

Q)   Course Curriculum Developer

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A)	**Course Title:** Open Educational Resources (OER)	
B)	**Course Code:** NEP02	
C)	**Pre- requisite (s):**	

D) **Rationale:** OER are freely and publicly available teaching, learning, and research resources that reside in the public domain in any format or have been released under an intellectual property license that permits their free use and re-purposing by others.

Learning about Open Educational Resources (OER), copyright, and Creative Commons licenses is a valuable endeavour for content creators, users, and anyone interested in sharing knowledge and creative works.

Creative Commons licenses, offer a standardized way to grant permissions for the use and sharing of creative works. Learning about OER, copyright, and Creative Commons licenses is an ongoing process. As these fields evolve, it's important to stay informed and continue exploring new resources and practices.

After going through this course, learners will at first place have reasonable idea to explore and use various OERs useful for their course of study and secondly, be motivated for fair use of resources available to them on various platform by understanding the restrictions and legal issues related to copyright and other licensing policies.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
NEP02.CO1	Evaluate Open Educational Resources (OER) for its authentic use.
NEP02.CO2	Use copyright material appropriately.
NEP02.CO3	Implement suitable Creative Common License.

F)   Suggested Course Articulation Matrix (CAM): (Not Applicable)

G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
NEP02	NEP	Open Education Resources	15	-	-	15	30	01	25	-	25	-	-	-	50

H)   Course Curriculum Detailing: For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Explain the difference between OER and other free educational materials. *TSO 1b.* Elaborate the challenges and benefits of using OER in a class. *TSO 1c.* Apply various aspects of evaluating OER before use *TSO 1d.* Explain the necessity to assess an OER's adaptability. *TSO 1e.* Perform preliminary search for open educational resource. *TSO 1f.* Find OER using various resources.	**Unit-1.0 Open Educational Resources** 1.1 OER - definition 1.2 What is NOT OER. 1.3 Benefits of using OER – Benefits to Students - Access to Quality Education 1.4 OER - Benefits to Faculty - Use, Improve and Share, Network and collaborate with peers, Lower Cost, Improve access to information 1.5 Challenges of Using OER – Subject Availability, Format and Material type availability, Time and Support availability 1.6 Evaluating OER – a) Clarity, Comprehensibility, and Readability, b) Content and Technical Accuracy, c) Adaptability and Modularity, d) Appropriateness and Fit, e) Accessibility 1.7 Finding Open Content - OER Search Scenario Filter by Usage Rights in Google, Repositories	**CO1**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	and Search Tools, Subject-specific Repositories	
TSO 2a. Explain benefits of copyright protection for creator TSO 2b. Explain exceptions and limitations to copyright law TSO 2c. List rights granted to copyright holders. TSO 2d. Explain Exceptions and limitations to copyright law TSO 2e. Explain Fair use/fair dealing apply to copyright TSO 2f. Elaborate Public domain and how does it relate to copyright TSO 2g. Elaborate penalties for copyright infringement. TSO 2h. Explain copyright for digital content and the internet. TSO 2i. Explain use of copyrighted works in education TSO 2j. Explain the use of free licenses	**Unit-2.0 Copyright and Open Licensing** 2.1 Copyright and what it does protect, benefits of copyright protection for creators, duration of copyright protection last, rights granted to copyright holders. 2.2 Exceptions and limitations to copyright law, fair use/fair dealing apply to copyright 2.3 Public domain and its relation to copyright. 2.4 Penalties for copyright infringement 2.5 Apply copyright to digital content and the internet 2.6 Use of copyrighted works in education. 2.7 Open Licenses – GNU – Free Documentation license, Free Art License 2.8 Why Free Licenses – Retain, Reuse, Revise, Remix, Redistribute	CO2
TSO 3a. Describe the four different Creative Commons License components. TSO 3b. Explain the significance of No-Derivative license TSO 3c. Explain the Strengths and weaknesses of four Open CC Licenses TSO 3d. Choose the right Creative Commons license for work. TSO 3e. Apply a Creative Commons license to existing work. TSO 3f. Use Creative Commons licenses for commercial purposes. TSO 3g. Modify a work licensed under Creative Commons. TSO 3h. Revoke a Creative Commons license, combine works with different Creative Commons licenses TSO 3i. Differentiate between Attribution and Citation	**Unit-3.0 Creative Common Licenses** 3.1 Alternatives to copyright as Creative Commons licenses. 3.2 Four components of creative common Licenses – Attribution, Share- Alike, Non – commercial, No Derivatives 3.3 Choosing a Creative Common licenses – Wiley's 5 Rs and Creative Common Licenses 3.4 Four Open CC Licenses and Their Strengths and Weaknesses – (a) CC BY (b) CC BY SA (c) CC BY NC (d) CC BY NC SA 3.5 Attribution Vs Citation - Creative Commons licensed work without giving attribution 3.6 Apply a CC License - choose the right Creative Commons license for work, apply a Creative Commons license to existing work, Creative Commons licenses be used for commercial purposes, modify a work licensed under Creative Commons, revoke a Creative Commons license, combine works with different Creative Commons licenses	CO3

J)   Suggested Laboratory Experiences: (Not Applicable)

K)   Suggested Research Based Problems

   i.   Collect information on the impact of OER on cost savings and student engagement.

    ii.   Search at least four OER related to topic of your Engineering Discipline over Internet. Evaluate the material based on the relevance, accuracy and usability.

    iii.   Explore the different types of resources under creative Commons licenses (e.g., CC BY, CC BY-SA, CC BY-NC, etc.) and their specific permissions and restrictions.

    iv.   Create a comparative analysis chart or infographic that visually represents the key characteristics of each license. Select minimum 5 real-world examples from different domains (such as music, art, literature, or education) where creators have used Creative Commons licenses

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L)   Suggested Term Work (TW):

    a.   Assignments: (Seminar Topics/ Visits/ Self- Learning Topics)
Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

    b.   Seminar Topics:

- OER Quality Assurance
- OER Repositories and Platforms
- Creative Commons and Digital Media
- Creative Commons in the Visual Arts
- Examine the legal implications of using Creative Commons licenses, including the obligations and responsibilities of both creators and users and present it.

M)   Suggested Specification Table for End Semester Theory Assessment (ETA): (Not Applicable)

N)   Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O)   Major Equipment, Tools and Software for Laboratory and Research Work: (Not Applicable)

P)   Suggested Learning Resources:

   a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	The OER Starter Kit.	Abbey Elder - 2019	IA: Iowa State University Digital Press, available under a Creative Commons Attribution 4.0 International License. Retrieved from iastate.pressbooks.pub/oerstarterkit
2.	A Brief History of Open Educational Resources	Bliss, T J and Smith, M. - 2017	In: Jhangiani, R S and Biswas-Diener, R. (Eds.) Open: The Philosophy and Practices that are Revolutionizing Education and Science (pp. 9–27). London: Ubiquity Press. DOI: https://doi.org/10.5334/bbc.b.

   b) Online Educational Resources (OER):

   1)   OER for Empowering Teachers Instructional Material by P. Malliga is licensed under a Creative Commons Attribution 4.0 International License.
   2)   William & Flore Hewlett Foundation. (n.d.). OER defined. Retrieved from https://hewlett.org/strategy/open-educational-resources/
   3)   Free Software Foundation. (2008). GNU Free Documentation License. Retrieved from https://www.gnu.org/licenses/fdl.html
   4)   Copyleft Attitude. (2007). Free Art License 1.3. Retrieved from http://artlibre.org/licence/lal/en/
   5)   Free Software Foundation. (n.d.). What is copyleft? Retrieved from https://www.gnu.org/copyleft/copyleft.html

Q)   Course Curriculum Development Team

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A)	**Course Title:** Professional Ethics
B)	**Course Code:** NEP03
C)	**Pre- requisite (s):** General awareness about moral values and about different workplaces

D) **Rationale:** The Course on Professional Ethics equips graduates with the moral frameworks necessary to handle complex challenges inherent in any profession. In the course, graduates will be exposed to situations involving ethical dilemmas, where robust decision-making is critical for integrity, trust, and societal well-being. This course will cover concepts and principles associated with values, ethics, code of conduct, empathy, and compassion, with a view to fostering a proactive approach to ethical conduct and building resilience. It will also help to cultivate responsible leadership, enhance employability, mitigate risks, and empower individuals to contribute positively to their professions and the broader community in an increasingly interconnected world. This course is meant to sensitize students to ethical considerations within their professions and motivate them to demonstrate ethical behaviour in day-to-day activities.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
NEP03.CO1	Make decisions considering values, moral and ethical framework.
NEP03.CO2	Propose fair professional practices considering the set of values and code of ethics in a simulated situation
NEP03.CO3	Demonstrate reasonable empathic and compassionate behaviour in professional settings.

F)   **Suggested Course Articulation Matrix (CAM):**

Course Outcomes (COs)	Programme Outcomes (POs)		
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/document.	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
NEP03.CO1	3	3	1
NEP03.CO2	2	2	1
NEP03.CO3	2	2	1

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   **Teaching & Learning and Assessment Scheme:**

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
NEP03	NEP	Professional Ethics	15	-	-	15	30	01	25	-	25	-	-	-	50

H)   **Course Curriculum Detailing:** For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Explain the interrelationship between values, morals and ethics. TSO 1b. Explain the influence of values, morals and ethics on the development of attitudes. TSO 1c. Identify values using self-assessment tools. TSO 1d. Describe a moral framework. TSO 1e. Use values and morally related criteria for making decisions in a given situation.	**Unit -1.0 Values, Morals and Ethics in Day-to-Day Life** 1.1 Introduction to values, moral, and ethics, definition, types of values, examples, Concept of attitude and development of attitude 1.2 Values identification using self-assessment tool, Moral Framework and its features, Importance of values and morals in day-to-day activities and at the workplace 1.3 Value-based decision criteria - Long-term versus short-term value considerations, Personal values alignment with professional choices 1.4 Moral Principles and Moral Reasoning Process	**CO1**
TSO 2a. Explain the characteristics that define a profession TSO 2b. Describe the role of professional associations in establishing and enforcing ethical standards. TSO 2c. Communicate effectively with integrity TSO 2d. Identify the ethical principles in the given professional codes TSO 2e. Suggest fair professional practices in simulated situation	**Unit-2.0 Professionalism and Codes of Conduct** 2.1 Profession and Professionalism 2.2 Role of Professional Associations and Societies 2.3 Ethics in communication**,** non-violent communication 2.4 Common Code of Ethics/Conduct for different professions, Academic ethics, environmental ethics, and Digital Ethics	**CO2**
TSO 3a. Explain the difference between compassion and empathy TSO 3b. Explain the role of emotional intelligence in empathy TSO 3c. Demonstrate empathy in a given situation TSO 3d. Explain the key stages for compassion development TSO 3e. Identify the compassion quotient using a questionnaire TSO 3f. Resolve ethical conflicts according to moral values and ethics. TSO 3g. Suggest for appropriate behaviour in a given personal and professional setting	**Unit-3.0 Empathic and Compassionate Behavior** 3.1 Introduction to Empathy and Compassion- Definition and Key Differences, Emotional Intelligence, and its role in empathy 3.2 Building blocks of empathy – active listening, Perspective-Taking, emotional cues 3.3 Key stages of compassion development in humans, compassion Quotient 3.4 Balance between Compassion and Empathy 3.5 Identification of activities in one's own area of work and related ethical and unethical behaviour, Ethical boundaries, Ethical Conflicts	**CO3**

J)   Suggested Laboratory Experiences: (Not Applicable)

K)   Suggested Research Based Problems

One problem is to allocate to each student. More such problems as mentioned below can be included by the teacher

   i.   Literature review on the psychology behind ethical and non-ethical behaviour

   ii.   Analysis of the ethical dilemma situation (such as the Ethical dilemma faced by engineers when they discover a design flaw or safety risk that a company is unwilling to address).

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L)   Suggested Term Work (TW):

   a.   **Assignment(s):** Preparing a report, critique, undertaking discussion in groups after reading books related to values and ethics/Epics/ Daily newspapers and (Any one)

   b.   **Activities: G**roup discussion, panel discussion, role play, case study, skits related to issues on values and ethics in the profession and day-to-day life. (These can be instructional strategies for the course, and can be specified clearly)

   c.   **Micro Projects:** Development of skits and performance, poster making,

   d.   **Other (Any one Topic)**

         Suggested Seminar/ Debates on topics such as:

         • Charters of professions
         • Importance of values and ethics in the identified profession
         • Issues of ethical conflicts
         • Identified issues from scripts such as the Chanakya Neeti, Kabir ke Dohe etc.
         • Lessons on ethics from religious scriptures
         • Nonviolent communication for good work culture
         • Compassion measurement at workplace
         • Issued based on happenings reported in daily news

         Teacher can suggest supporting material for reference and preparation.

M)   Suggested Specification Table for End Semester Theory Assessment (ETA): (Not Applicable)

N)   **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O)   **Major Equipment, Tools and Software for Laboratory and Research Work:** (Not Applicable)

P)   **Suggested Learning Resources:**

    a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Professional Ethics and Human Values	D. R. Kiran	McGraw-Hill Education Pvt. Ltd. 2007 ISBN: 9780070633872
2.	A Textbook on Professional Ethics and Human Values	Dr. R S Nagarajan	New Age International (P) Ltd., Publishers, 2017, ISBN: 8122419380, 9788122419382
3.	Ethics, Integrity and Attitude –Hindi (Paperback) (एथिक्स, सत्यनिष्ठा एवं अभिवृत्ति)	P.D Sharma	Rawat Publications, 2019 ISBN: 978-8131609941
4.	Chanakya - Niti (Sutra Sahit) (Hindi)	Chanakya	Maple Press. 2014 ISBN 978-9350335529
5.	Professional Ethics and Human Values	D. R. Kiran	McGraw-Hill Education Pvt. Ltd. 2007 ISBN: 9780070633872

    b) Online Educational Resources (OER):

      1)   https://tibet.emory.edu/documents/Ozawa-deSilva-CompassionandEthics-FinalPrintVersion-JHSH2012.pdf

      2)   https://www.surendranathcollege.ac.in/wp-content/uploads/2024/02/7.1.9.-HUMAN-VALUES-AND-PROFESSIONAL-ETHICS.pdf

      3)   https://harmoniouscosmos.com/the-role-of-compassion-in-ethical-decision-making/

      4)   https://www.uhv.org.in/uhve

      5)   https://www.kaggle.com/rohankayan/years-of-experience-and-salary-dataset

      6)   http://gandhismriti.gov.in/sites/default/files/Nonviolent%20Communication%20Elements%20and%20Applications%20%281%29.pdf

Q)   **Course Curriculum Development Team**

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(Deemed to be University under Distinct Category), MOE, GOI

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A)	**Course Title:** Financial Literacy
B)	**Course Code:** NEP04
C)	**Pre- requisite (s):**

D) **Rationale:** Financial literacy is a critical life skill that everyone should have, yet many people struggle with it. This course explores the fundamentals of financial literacy, including budgeting, saving, investing, and debt management. The students will learn the fundamental principles of budgeting, saving, and investing, along with understanding the key factors that can impact the financial decisions.it communicates the different investment options and the risk-return trade-offs. It also can create a diversified portfolio that fits your risk tolerance and investment goals. In addition to investment strategies, this course covers topics such as credit and debt management, retirement planning, taxes, and insurance.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
NEP04.CO1	Formulate the investment plan for various situation of income & expenditure of individuals.
NEP04.CO2	Identify various Investment Options for Retirement.
NEP04.CO3	Apply Tax-Effective Investment Decisions for various situations.

F)   Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)				
	PO-1 Apply knowledge of management theories and practices to solve business problems.	**PO-2** Foster Analytical and critical thinking abilities for data-based decision-making.	**PO-3** Ability to develop Value based Leadership ability.	**PO-4** Ability to understand, analyze and communicate global, economic, legal, and ethical aspects of business.	**PO-5** Ability to lead themselves and others in the achievement of organizational goals, contributing effectively to a team environment.
NEP04.CO1	1	-	1	-	-
NEP04.CO2	1	1	1	-	-
NEP04.CO3	1	-	1	-	-

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
NEP04	NEP	Financial Literacy	15	-	-	15	30	01	25	-	25	-	-	-	50

H)   Course Curriculum Detailing: For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Explain the Personal Financial Goals for the given situation. *TSO 1b.* Explain Income/ Expenses/ Net Worth for the given situation.	**Unit-1.0: Basic Financial Concepts** 1.1 Personal Financial Goals 1.2 Income, Expenses, and Net Worth	**CO1, CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1c. Explain the steps of Budgeting for the given situation.	1.3 Budgeting & Cash Flow Management	
TSO 1d. Explain the Cash Flow Management process for the given situation.	1.4 Saving 1.5 Investing	
TSO 1e. Explain Saving for household for the given situation.	1.6 Inflation & Interest Rates 1.7 Bank Accounts and Payment Methods	
TSO 1f. Formulate the investment plan for the given individual.	1.8 Credit Management 1.9 Debt Management	
TSO 1g. Explain Inflation in the economy	1.10 Insurance	
TSO 1h. Identify the factors effecting the Interest Rates in the economy for the given situation.		
TSO 1i. Explain the role of Bank Accounts in personal savings for the given situation.		
TSO 1j. Explain the Payment Methods.		
TSO 1k. Explain the Credit Management system for the given situation.		
TSO 1l. Explain Debt Management for the given situation.		
TSO 1m. Explain the Insurance plan for the given situation.		
TSO 1n. Formulate the investment plan for the given situation of income & expenditure of individuals.		
TSO 2a. Identify the various the Investment option and types for the given situation.	**Unit-2.0: Investing & Taxation**	**CO2**
TSO 2b. Building a Diversified Portfolio applying risk-return trade-off for the given situation.	2.1 Investment option and types 2.2 Building a Diversified Portfolio	
TSO 2c. Apply the Risk-Return Trade-off for the given situation.	2.3 Risk-Return Trade-off 2.4 Informed Investment Decisions	
TSO 2d. Explain Informed Investment Decisions for the given situation.	2.5 Retirement Planning 2.6 Social Security and Pensions	
TSO 2e. Write the steps in Retirement Planning for the given situation.	2.7 Estimating Future Retirement Expenses 2.8 Planning for a Comfortable Retirement	
TSO 2f. Explain Social Security and Pensions for the given situation.	2.9 Investment Options for Retirement Savings	
TSO 2g. Identify the Investment Options for Retirement Savings for the given situation.	2.10 Planning for Unexpected Events	
TSO 2h. Make Plans for Unexpected Events for the given situation.	2.11 Filing Taxes and Forms 2.12 Tax Laws and Regulations	
TSO 2i. List the Filing Taxes and Forms	2.13 Minimizing Tax Liability	
TSO 2j. Outline the Tax Laws and Regulations.	2.14 Making Tax-Effective Investment Decisions	
TSO 2k. Minimizing Tax Liability for the given situation.		
TSO 2l. Make Tax-Effective Investment Decisions for the given situation.		

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 3a. Explain the importance of Entrepreneurship education *TSO 3b.* Outline the Entrepreneurial Opportunities for the given product. *TSO 3c.* Outline the Entrepreneurship Support Eco-System *TSO 3d.* Identify the Business opportunities for the given situation. *TSO 3e.* Identify the steps in market survey for an enterprise. *TSO 3f.* Identify the Procedure and formalities for Bank Finance for the given situation	**Unit-3.0: Entrepreneurship Support System** 3.1 Entrepreneurship education 3.2 Achievement Motivation 3.3 Entrepreneurial Opportunities 3.4 Entrepreneurship Support Eco-System 3.5 Business opportunities Identification 3.6 Market Survey 3.7 Procedure and formalities for Bank Finance	**CO3**

J)   Suggested Laboratory Experiences: (Not Applicable)

K)   Suggested Research Based Problems

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L)   Suggested Term Work (TW):

a.   Assignment(s):

Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b.   Visits:

- Arrange a visit to a tax filing consultancy nearby.

c.   Group discussions on current print articles.

- Personal finance
- Taxation over last decade
- Essentials awareness for IT slabs.

d.   Self-learning topics:

- Cash Management System for firms.
- Accounts receivable for firms.

e.   Micro Projects: Suggested list of course wise micro projects are mentioned herewith

• Analysis of Situations where special provisions for saving has been observed
• Role of Media in Spreading Awareness regarding Tax filing.

f.   Seminar Topics:

• The Evolution of the Indian Constitution: From the British Raj to Independence
• Filling Income tax as per Indian Provisions.
• Planning for retirement.

M)   Suggested Specification Table for End Semester Theory Assessment (ETA): (Not Applicable)

N)   Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O)   Major Equipment, Tools and Software for Laboratory and Research Work: (Not Applicable)

P)   Suggested Learning Resources:
   a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Exploring Financial Literacy	Judi Deatherage M. D	Goodheart-Willcox , ISBN-13: 9781635637069
2.	The Money Guide by	Anushka Rathod	Zebralearn Pvt Ltd, ISBN-13: 978-8196373566
3.	Money Works: The Guide to Financial Literacy	Abhijeet Kolapkar	Publisher Penguin Business, ISBN-13: 978-0143461647
4.	Financial Literacy	Prof. Rajni and Dr. Abhishek Kumar Singh	JSR Publishing House LLP
5.	Taxmann's Financial Literacy – Equip Yourself With The Knowledge And Skills To Achieve Financial Independence and Make Informed Financial Decisions Confidently	Prof. (Dr.) Amit Kumar Singh	Taxmann Publications Private Limited; ISBN-13 : 978-9357785464
6.	Personal Finance: A Treatise on Financial Literacy	Prof (Dr.) Kana Sukumaran	Notion Press, ISBN-13: 979-8894463421
7.	The Legacy Of Financial Literacy : Guiding My Child To Financial Success	Jyotinath Ganguly	Notion Press, ISBN-13: 978-1637453223

b) Online Educational Resources (OER):

1) https://www.investopedia.com/guide-to-financial-literacy-4800530#:~:text=Financial%20literacy%20is%20the%20ability%20to%20understand%20and,money%2C%20compound%20interest%2C%20managing%20debt%2C%20and%20financial%20planning.
2) https://www.fidelity.com/learning-center/smart-money/financial-literacy
3) https://www.forbes.com/sites/truetamplin/2023/09/21/financial-literacy--meaning-components-benefits--strategies/
4) https://yourstory.com/2023/07/financial-literacy-is-key-to-unlocking-india-economy
5) https://www.investopedia.com/financial-literacy-5224001

Q)   Course Curriculum Developer

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A)	**Course Title:** Engineering Economics
B)	**Course Code:** NEP05
C)	**Pre- requisite (s):**

D)   Rationale: The need of engineering economy is primarily motivated by the fact that everything in engineering has to be carried out economically and optimally - whether designing an equipment, choosing between alternatives, operating a plant, marketing a product or maintaining a plant, all of which involve a decision-making process. The decision-making process involves the fundamental elements of cash flows of money, time, and interest rates. This course introduces the basic concepts and terminology necessary for an engineer to combine these three essential elements to solve problems that will lead to better decisions.

E)   Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
NEP05.CO1	Apply the laws of economics for various situations.
NEP05.CO2	Evaluate the various engineering project w.r.t. Present worth method, Future worth method, Net present value method, internal rate of return method, Cost-benefit analysis in public projects
NEP05.CO3	Prepare cost sheets for the various products.

F)   Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)				
	PO-1 Apply knowledge of management theories and practices to solve business problems.	**PO-2** Foster Analytical and critical thinking abilities for data-based decision-making.	**PO-3** Ability to develop Value based Leadership ability.	**PO-4** Ability to understand, analyze and communicate global, economic, legal, and ethical aspects of business.	**PO-5** Ability to lead themselves and others in the achievement of organizational goals, contributing effectively to a team environment.
NEP05.CO1	1	-	1	-	-
NEP05.CO2	1	1	1	-	-
NEP05.CO3	1	-	1	-	-

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		Total Marks (TA+TWA+LA)
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
NEP05	NEP	Engineering Economics	15	-	-	15	30	01	25	-	25	-	-	-	50

H)   Course Curriculum Detailing:
For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Outline the scope of Engineering Economics. *TSO 1b.* Explain micro & macro-economics. *TSO 1c.* Explain the Theory of demand *TSO 1d.* Explain the demand function for the given situation. *TSO 1e.* List the exceptions of Law of Demand. *TSO 1f.* Explain the Elasticity of demand. *TSO 1g.* Explain the elasticity of demand for the given product. *TSO 1h.* Explain the Laws of variable proportions for the given situation. *TSO 1i.* Explain the Law of returns to scale. *TSO 1j.* Apply the relevant laws of economics for the given situation.	**Unit-1.0 Basic Economics Concepts** 1.1 Engineering Economics – Nature and scope 1.2 General concepts on micro & macro-economics. 1.3 The Theory of demand: Demand function, Law of demand and its exceptions, 1.4 Elasticity of demand, Law of supply and elasticity of supply. 1.5 Theory of production: Law of variable proportion, Law of returns to scale	
TSO 2a. Identify the factors in Time value of money. *TSO 2b.* Explain the Principle of economic equivalence *TSO 2c.* Identify the methods of evaluation of engineering projects. *TSO 2d.* Calculate the Net present value method, internal rate of return method, Cost-benefit analysis for the given product	**Unit-2.0: Time Value of Money** 2.1 Time value of money: Simple and compound interest, Cash flow diagram, Principle of economic equivalence. 2.2 Evaluation of engineering projects: Present worth method, Future worth method, Net present value method,	CO2

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 2e. Explain Depreciation. TSO 2f. Distinguish the methods of depreciation. TSO 2g. Evaluate the given engineering project w.r.t. Present worth method, Future worth method, Net present value method, internal rate of return method, Cost-benefit analysis in public projects	internal rate of return method, Cost-benefit analysis in public projects. 2.3 Depreciation: Meaning Causes, Factors affecting depreciation, Methods of providing depreciation, Straight Line Method & Diminishing Balance Method	
TSO 3a. List the elements of costs. TSO 3b. Differentiate between fixed and variable costs TSO 3c. Explain BEP for the given product. TSO 3d. Calculate BEP for the given situation. TSO 3e. Explain the characteristic of the Indian banking system. TSO 3f. Explain the functions of commercial banks. TSO 3g. Explain the functions of Reserve Bank of India. TSO 3h. Outline the Indian Financial System. TSO 3i. Prepare a cost sheet for the given product.	**Unit-3.0: Cost and Banking Concepts** 3.1 Cost concepts: Elements of costs, Preparation of cost sheet, Segregation of costs into fixed and variable costs. Break-even analysis (Simple numerical problems to be solved) 3.2 Indian Banking System: Banks: Meaning, nature, characteristic of the Indian banking system, functions of commercial banks, functions of Reserve Bank of India, Overview of Indian Financial System.	CO3

J) Suggested Laboratory Experiences: (Not Applicable)

K) Suggested Research Based Problems

a. Cost-Benefit Analysis of Green Technologies
- Problem: How can cost-benefit analysis be used to justify investments in sustainable and green technologies in industries?
- Focus: Evaluation of long-term economic benefits vs. initial investment costs of green technologies such as solar power, energy-efficient systems, and eco-friendly materials.

b. Optimization of Project Scheduling Using Economic Principles
- Problem: How can engineering economic principles be applied to optimize project timelines while minimizing costs?
- Focus: Investigating the economic impact of scheduling delays and exploring methods like Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT).

c. Economic Viability of Renewable Energy Systems
- Problem: What is the economic feasibility of replacing traditional energy sources with renewable energy in large-scale projects?
- Focus: Cost analysis of renewable energy sources like wind, solar, and hydropower and their integration into existing infrastructures.

d. Risk and Uncertainty in Engineering Investment Decisions
- Problem: How can risk analysis techniques help improve investment decision-making in engineering projects?

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- Focus: Exploring methods to quantify risk and uncertainty, such as Monte Carlo simulations or sensitivity analysis, and their application in engineering economics.

e. **Economic Impact of Automation in Manufacturing**
- Problem: What are the long-term economic effects of implementing automation in manufacturing processes?
- Focus: Investigating cost reduction, labor displacement, and productivity increases due to automation, and analyzing the return on investment (ROI).

f. **Capital Budgeting and Infrastructure Development**
- Problem: How can engineering economic models be used to evaluate large-scale infrastructure projects like bridges, highways, or airports?
- Focus: Applying techniques like Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period for evaluating capital expenditures in public infrastructure.

g. **Lifecycle Costing in Engineering Design**
- Problem: How can lifecycle costing be integrated into the design phase of engineering projects to improve long-term financial outcomes?
- Focus: Assessing the total cost of ownership (TCO) of systems or products from conception to disposal and its impact on engineering decisions.

h. **Sustainability vs. Profitability in Engineering Projects**
- Problem: How can sustainability practices be balanced with profitability in engineering project management?
- Focus: Analyzing the trade-offs between short-term profits and long-term sustainability goals, and finding ways to integrate them economically.

i. **Impact of Inflation on Engineering Project Costs**
- Problem: What is the effect of inflation on the cost estimation and budgeting of long-term engineering projects?
- Focus: Developing models to predict and mitigate inflation's impact on project finances and exploring strategies to safeguard against cost overruns.

j. **Economic Analysis of Infrastructure Resilience**
- Problem: How can economic models be used to assess the cost-effectiveness of building resilient infrastructure in the face of climate change or natural disasters?
- Focus: Cost-benefit analysis of resilient infrastructure investments, including disaster recovery costs and insurance savings.

k. **Evaluating Engineering Project Feasibility Using Real Options Theory**
- Problem: How can real options theory be applied to evaluate the feasibility and flexibility of engineering projects under uncertainty?
- Focus: Investigating how real options, such as delaying or expanding projects, can be modeled to improve decision-making in uncertain environments.

l. **Public-Private Partnerships in Engineering: Economic Considerations**
- Problem: What are the key economic challenges and benefits of public-private partnerships (PPP) in engineering infrastructure projects?

- Focus: Exploring the economic models that can be used to balance risks, rewards, and resource allocation between public and private sectors.

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L)   Suggested Term Work (TW):

a.   Assignment(s):

Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

i. Time Value of Money (TVM) Calculations
- Assignment: Explain and apply the concept of the time value of money. Calculate the future value and present value of different cash flows using different interest rates. Analyze how inflation impacts these calculations.
- Objective: Understand and apply TVM concepts to real-world investment decisions.

ii. Cost-Benefit Analysis for a New Engineering Project
- Assignment: Perform a cost-benefit analysis for a hypothetical or real-world engineering project (e.g., construction of a bridge, solar power plant, or water treatment facility). Identify all potential costs and benefits, and calculate the net benefit.
- Objective: Apply cost-benefit analysis techniques to evaluate the feasibility of engineering projects.

iii. Break-even Analysis in Manufacturing
- Assignment: Conduct a break-even analysis for a manufacturing process. Identify fixed and variable costs, and determine the break-even point. Create different scenarios by changing costs and price points.
- Objective: Learn how to determine profitability thresholds and manage operational costs in manufacturing.

iv. Capital Budgeting for Infrastructure Projects
- Assignment: Using techniques like Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period, evaluate a proposed infrastructure project (e.g., road construction, airport expansion). Analyze the financial viability and make a recommendation.
- Objective: Apply capital budgeting techniques to large-scale engineering projects.

v. Depreciation Methods and Their Impact on Project Economics
- Assignment: Explore various depreciation methods (e.g., straight-line, declining balance, sum-of-years-digits) and apply them to engineering assets (e.g., machinery, vehicles). Analyze how different methods affect tax savings and project economics.
- Objective: Understand how depreciation impacts financial decision-making and project budgeting.

vi. **Life-Cycle Cost Analysis of Engineering Equipment**
- Assignment: Perform a life-cycle cost (LCC) analysis for an engineering system or equipment (e.g., HVAC system, machinery). Consider initial costs, operation, maintenance, and disposal. Compare two alternatives based on LCC.
- Objective: Assess the total cost of ownership of engineering systems from inception to disposal.

vii. **Sensitivity Analysis for an Engineering Project**
- Assignment: Perform a sensitivity analysis on an engineering project's financial model. Identify critical variables (e.g., cost of materials, labor rates, interest rates) and assess how changes in these variables affect the project's profitability.
- Objective: Learn how to account for uncertainty and variability in project costs and decision-making.

viii. **Inflation and Its Impact on Long-Term Engineering Projects**
- Assignment: Analyze the impact of inflation on long-term engineering projects, such as power plants or public infrastructure. Calculate how inflation rates affect future costs and overall project budgets.
- Objective: Understand how inflation impacts project budgeting and long-term financial planning.

ix. **Economic Analysis of Renewable Energy Projects**
- Assignment: Evaluate the economic feasibility of a renewable energy project (e.g., wind farm, solar energy plant) by calculating the return on investment, break-even point, and long-term financial benefits.
- Objective: Learn how to assess the financial viability of sustainable engineering solutions.

x. **Risk and Uncertainty in Investment Decisions**
- Assignment: Analyze a case study of an engineering project where risk and uncertainty played a significant role. Use probabilistic methods, such as Monte Carlo simulations or decision trees, to model the impact of uncertainty on project outcomes.
- Objective: Develop skills in managing risk and uncertainty in engineering economics.

xi. **Public-Private Partnership (PPP) Analysis**
- Assignment: Analyze a public-private partnership (PPP) project in engineering (e.g., highway construction or airport management). Assess the risk-sharing model, economic benefits, and potential challenges from both public and private perspectives.
- Objective: Explore the economic considerations and challenges in engineering projects involving multiple stakeholders.

xii. **Inventory Management and Economic Order Quantity (EOQ)**
- Assignment: Apply the Economic Order Quantity (EOQ) model to an engineering firm's inventory management system. Calculate EOQ and analyze the trade-off between ordering costs and holding costs.
- Objective: Understand the principles of efficient inventory management in engineering operations.

xiii. **Feasibility Study of Automation in a Production Line**
- Assignment: Conduct a financial feasibility study to assess the benefits and costs of automating a manufacturing production line. Consider factors such as labor cost savings, capital costs, and operational efficiency.
- Objective: Assess the economic impact of automation in engineering.

xiv. **Engineering Project Financing**
- Assignment: Explore different financing options available for large engineering projects (e.g., project loans, bonds, equity). Analyze the pros and cons of each financing option and their impact on project cost and risk.
- Objective: Understand how financial structures affect the economics of engineering projects.

xv. **Ethical and Economic Considerations in Engineering Projects**
- Assignment: Analyze an engineering project with significant ethical and economic implications (e.g., building in environmentally sensitive areas, projects affecting communities). Explore the balance between economic benefits and ethical responsibility.
- Objective: Learn to integrate ethical considerations with economic decision-making in engineering projects.

b. **Seminar Topics:**

- Time Value of Money in Engineering Projects
- Cost-Benefit Analysis in Large Infrastructure Projects
- Depreciation Methods and Their Impact on Engineering Economics
- Economic Feasibility of Renewable Energy Projects
- Break-even Analysis in Engineering and Manufacturing
- Capital Budgeting Techniques in Engineering
- Risk and Uncertainty in Engineering Economic Decisions
- Lifecycle Costing in Engineering Systems
- Public-Private Partnerships (PPP) in Engineering Projects
- Sustainability and Economic Viability in Engineering
- Economic Order Quantity (EOQ) and Inventory Management
- Impact of Inflation on Engineering Projects
- Automation and Its Economic Impact on Manufacturing
- Economic Impact of Lean Manufacturing
- Financing Large-Scale Engineering Projects
- Feasibility Studies for Engineering Projects
- Economic Implications of Engineering Ethics
- Supply Chain Economics in Engineering
- Real Options in Engineering Project Evaluation
- Economic Evaluation of Disaster-Resilient Infrastructure

M)   Suggested Specification Table for End Semester Theory Assessment (ETA): (Not Applicable)

N) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O) **Major Equipment, Tools and Software for Laboratory and Research Work:** (Not Applicable)

P) **Suggested Learning Resources:**
   a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Engineering Economics	Riggs, Bedworth and Randhwa	McGraw Hill Education India, ISBN: 9780079122483
2.	Principles of Economics	D.M. Mithani	Himalaya Publishing House, ISBN:978-93-5202-762-0
3.	Engineering Economics & Costing	Sasmita Mishra	PHI Learning Pvt. Ltd, ISBN: 9788120341678
4.	Engineering Economy	Sullivan and Wicks	Pearson Hall, ISBN: 9780132554909
5.	Engineering Economics	R.Paneer Seelvan	Prentice-Hall of India Pvt. Ltd, ISBN: 788120348370
6.	Managerial Economics	Gupta G	McGraw Hill Education, ISBN-13:978-0071067867
7.	Cost Accounting: Text, Problems and Cases	Jawahar Lal , Seema Srivastav , Manisha Singh	McGraw-Hill. ISBN-13: 978-9353168384

   b) Online Educational Resources (OER):

   1) http://courseware.cutm.ac.in/courses/engineering-economics-and-costing/
   2) https://ep.jhu.edu/courses/715641-engineering-economics/
   3) https://online.stanford.edu/courses/cee146s-engineering-economics-and-sustainability
   4) https://ocw.mit.edu/courses/10-490-integrated-chemical-engineering-i-fall-2006/98288885a32c8a4054460082cb87a426_eng_econ_lecture.pdf
   5) https://engineering.purdue.edu/online/courses/engineering-economic-analysis

Q) **Course Curriculum Developer**

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Course Curriculum Detailing- Offline Spell -2

A)	**Course Title:** Digital Manufacturing
B)	**Course Code:** CAMA04
C)	**Pre- requisite Course (s):**

D) Rationale: This course is essential as it comprehensively covers the evolution and modern advancements in manufacturing. It delves into virtual manufacturing and simulation tools, numerical control systems, computer-integrated manufacturing, and flexible manufacturing systems. Additionally, it explores smart manufacturing and Industry 4.0 technologies, highlighting the transformative roles of IoT, AI, and machine learning. This holistic approach ensures that students are prepared to lead and innovate in the rapidly evolving digital manufacturing landscape. The course emphasises strengthening theoretical and practical knowledge by demonstrating how to replace current manual procedures with digital alternatives. This comprehensive approach equips students with the skills needed to meet the demands of modern industries and R&D organisations, preparing them to lead and innovate in digital manufacturing.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of the following industry-expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
CAMA04.CO1	Analyze the architecture of various digital manufacturing systems
CAMA04.CO2	Apply various methods and tools in virtual manufacturing to optimize manufacturing processes.
CAMA04.CO3	Implement adaptive control systems to optimize various machining processes.
CAMA04.CO4	Apply various ML techniques for predictive maintenance and quality control.
CAMA04.CO5	Apply Various industry 4.0 technologies for quality assurance and predictive maintenance.

F)　Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)				
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/document.	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.	**PO-4** An ability to use modern tools and techniques related to CAD, Manufacturing, and Automation.	**PO-5** An ability to apply optimization techniques to provide a competitive optimal solution to real-world work problems.
CAMA04.CO1	2	2	3	-	-
CAMA04.CO2	-	-	3	-	-
CAMA04.CO3	3	-	3	3	-
CAMA04.CO4	3	-	3	3	3
CAMA04.CO5	-	3	-	3	2

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)　Teaching &Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA04	PCC	Digital Manufacturing	45	15	45	15	120	04	30	70	20	-	20	30	170

H)　Course Curriculum Detailing: For the attainment of course outcomes, the students are expected to perform/ undergo various activities in the classroom, laboratories/ workshops/ term work, and self-learning/ field sessions. As per the requirements of NEP: 2020, unique features like Green skills, Multidisciplinary Aspects, Societal Connect, IKS, and Renewable Energy are integrated appropriately.

I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Outline the historical perspective in digital manufacturing system. *TSO 1b.* Write in brief the role of the Industrial Revolution in digital manufacturing. System. *TSO 1c.* Differentiate between traditional and digital manufacturing systems. *TSO 1d.* Analyse the operation mode of given digital manufacturing. *TSO 1e.* Analyse the architecture of the digital manufacturing system.	**Unit-1.0 Digital Manufacturing** 1.1 Industrial Revolutions. 1.2 Historical perspective on industrial production. 1.3 Differences between traditional and digital manufacturing. 1.4 Factory of the future. 1.5 Operation Mode and Architecture of Digital Manufacturing System.	**CO1**
TSO 2a. Differentiate the given types of virtual manufacturing processes/ products/factories. *TSO 2b.* Identify the sequence of steps in the given virtual manufacturing processes from design to execution. *TSO 2c.* Identify the tools and methods used in virtual manufacturing. *TSO 2d.* Identify the method for the given virtual manufacturing. *TSO 2e.* Identify the virtual industrial application of virtual manufacturing. *TSO 2f.* Apply appropriate tools and methods in virtual manufacturing for optimization of the manufacturing process.	**Unit-2.0 Virtual Manufacturing** 2.1 Types of Virtual Manufacturing: Process simulation, Product simulation, Factory simulation 2.2 Virtual factory simulation, 2.3 Role of simulation in manufacturing 2.4 Methods and Tools used in Virtual Manufacturing. 2.5 Virtual Manufacturing Workflow. 2.6 Applications of Virtual Manufacturing, 2.7 Challenges and Future Trends.	**CO2**
TSO 3a. Explain the given NC, CNC, and DNC principles and their application in modern machining. *TSO 3b.* Compare conventional machining techniques with CNC systems, including their advantages and limitations. *TSO 3c.* Implement adaptive control systems to optimize machining processes based on real-time data and conditions. *TSO 3d.* Apply interpolators to generate complex tool paths for the given machining operations.	**Unit-3.0 Numerical control of Machine tools** 3.1 Principles of Numerical control (NC), Computer Numerical control (CNC), Direct Numerical control (DNC), 3.2 Comparison between conventional and CNC systems 3.3 Classification of CNC system, NC coordinate system, positional control, system devices; 3.4 Drives, ball screws, transducers, feedback devices, counting devices, signal converters, 3.5 Interpolators, adaptive control system.	**CO3**
TSO 4a. Outline the given hierarchical computer system. *TSO 4b.* Identify the components of CIM *TSO 4c.* Differentiate between the given flexible manufacturing systems. *TSO 4d.* Explain the system components with respect to application and benefits. *TSO 4e.* Explain the given manufacturing cell/tool	**Unit-4.0 CIM and FMS** 4.1 Hierarchical computer system 4.2 Concepts and Components of CIM, types of manufacturing systems, and transfer lines. 4.3 Flexible Manufacturing System, Types of Flexibility. 4.4 FMS Components, Application & Benefits.	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
management and workplace handling system. *TSO 4f.* Enlist the benefits of given CIM &FMS.	4.5 The manufacturing cell, tool management and workpiece handling system. 4.6 Benefits of CIM &FMS	
TSO 5a. Outline the role of the given IoT and cyber-physical system. *TSO 5b.* Explain the mechanism of integration of given IoT and Cyber-physical systems for manufacturing. *TSO 5c.* Enlist the benefits of given smart manufacturing techniques. *TSO 5d.* Identify the IoT/data/AI/ML technology in the given industry 4.0. *TSO 5e.* Explain the role of digital twins for the given industrial application.	**Unit 5.0: Smart Manufacturing and Industry 4.0** 5.1 Role of IoT and cyber-physical systems 5.2 Benefits of Smart Manufacturing 5.3 Industry 4.0 Technologies: Internet of Things (IoT), 5.4 Big data and analytics, Artificial Intelligence (AI) and Machine Learning (ML); 5.5 Introduction of digital twin	**CO5**

J)   Suggested Laboratory Experiences:

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number(s)
LSO 1.1 Utilize advanced digital tools for hands-on experience. LSO 1.2 Interpret simulation data to optimize manufacturing layouts.	1.	Design a basic layout for a future factory using digital tools.	CO1
LSO 2.1 Compare key features of traditional and digital manufacturing processes. LSO 2.2 Assess the impact of digital manufacturing on efficiency, cost, and product quality versus traditional methods.	2.	Conduct a comparative analysis of a traditional manufacturing process and a digital manufacturing process.	CO1
LSO 3.1 Develop Simulation Models for Manufacturing Processes. LSO 3.2 Optimize Manufacturing Process Parameters Based on Simulation Results	3.	Simulate a manufacturing process and analyse its performance.	CO2
LSO 4.1 Interpret Simulation Results to Improve Production Efficiency	4.	Use process/product simulation Software to model a production process.	CO2
LSO 5.1 Operate the CNC Machine safely. LSO 5.2 Produce quality parts	5.	Execute a CNC program for an essential machining operation.	CO3
LSO 6.1 Perform diagnostic tests on CNC systems. LSO 6.2 Evaluate the performance of positional control and feedback devices	6.	Investigate the functioning of positional control and feedback devices in a CNC system.	CO3
LSO 7.1 Configure automated tool changers for optimal performance. LSO 7.2 Operate handling systems to improve efficiency and workflow.	7.	Investigate the tool management system and workpiece handling in a Computer-Integrated Manufacturing (CIM) environment.	CO4

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number(s)
LSO 8.1 Implement feedback control systems. LSO 8.2 Utilize IoT devices to adjust processes in real-time based on received data.	8.	Set up IoT devices to monitor and control a manufacturing process.	CO5
LSO 9.1 Integrate the machine learning model for real-time predictions. LSO 9.2 Optimize manufacturing processes continuously for improved efficiency	9.	Implement a machine learning model to predict manufacturing outcomes	CO5
LSO 10.1 Analyze the digital twin simulation results. LSO 10.2 Implement targeted strategies to enhance manufacturing operations.	10.	Create a digital twin of a manufacturing system.	CO5

K) **Suggested Research Based Problems:**

- To develop and implement a digital twin model for real-time monitoring and optimization of a smart manufacturing system.
- To develop a predictive maintenance framework using AI and machine learning techniques for smart manufacturing systems.

Note: Depending on the requirement of each laboratory experience, micro project and research based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L) **Suggested Term Work (TW)**

    a. Assignment (s):

- IoT-Enabled Smart Manufacturing System: Develop a prototype of a smart manufacturing system incorporating IoT devices.
- Data Analytics in Manufacturing: Analyze a set of manufacturing data using data analytics tools and present the findings.
- Adaptive Control System for CNC Machines: Develop and test an adaptive control system for a CNC machine to enhance machining accuracy and efficiency.
- Process Simulation for Optimization: Develop a process simulation model to identify and optimize critical manufacturing parameters for improved productivity.

    b. Seminar Topics:

- The Role of Virtual Manufacturing in the Evolution of Industry 4.0.
- Digital Twins in Manufacturing: Real-time Monitoring and Optimization for Smart Factories.
- Exploring the Impact of Digital Measurement Tools on Quality Control in Manufacturing.
- Computer-Aided Design (CAD): Innovations Driving the Future of Product Development.

M) **Suggested Specification Table for End Semester Theory Assessment (ETA):** Questions may be designed based on the higher taxonomy level of the cognitive domain.

Cos	Relevant Unit Number and Title	Marks
CO1	Unit 1.0 Digital Manufacturing	12
CO2	Unit 2.0 Virtual Manufacturing	12
CO3	Unit 3.0 Numerical control of Machine tools	16
CO4	Unit 4.0 CIM and FMS	15
CO5	Unit 5.0 Smart Manufacturing and Industry 4.0	15
Total		**70**

N) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT) based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O) **Major Equipment, Tools and Software for Laboratory and Research Work:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experience /Practical Number
1.	Computer systems	Processor Intel Core i9, 64 GB RAM, 64 bit OS, Graphic card 64GB, Storage 2.75 TB	1, 2
2.	Taecnomatix software	Process and Product simulation package	3,4, 10
3	Computer Numerical Control Machines	Turing and Milling	5,6,7
4	Internet of Things	Machine Learning and IOT tools	8,9

P) **Suggested Learning Resources:**

a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Introduction to Digital Manufacturing	Richard Bibb, Dominic Eggbeer, Abby Paterson	Springer, year:2020, Ist Edition, ISBN: 978-3030185930
2	Virtual Manufacturing	Raj S. Sodhi	Springer, year:2010, Ist Edition, ISBN: 978-3642034204
3	Industry 4.0: The Industrial Internet of Things	Alasdair Gilchrist	Apress. Year:2016, Ist Edition, ISBN: 978-1484220463
4	Manufacturing Systems: Theory and Practice	George Chryssolouris	Springer, year:2006, Ist Edition, ISBN: 978-0387284314

b) **Online Educational Resources:**

1) https://www.coursera.org/learn/digital-manufacturing-design
2) https://www.coursera.org/learn/iot
3) https://openstax.org/
4) https://www.saylor.org/
5) https://www.futurelearn.com/

Q) **Course Curriculum Developer**

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A)	**Course Title:** PLC and PLC Programming
B)	**Course Code:** CAMA05
C)	**Pre- requisite Course (s):**

D)   Rationale: The PLC (Programmable Logic Controller) and PLC programming course is crucial for engineering students as it provides practical skills and theoretical knowledge essential for careers in industrial automation. By this course the students gain hands-on experience in designing, implementing and troubleshooting automated systems. This course not only bridges the gap between theory and application but also enhances critical thinking and problem-solving abilities through project-based learning. With industries increasingly relying on automation for efficiency and reliability, students equipped with PLC expertise are well-positioned for roles as automation engineers, control system designers, and maintenance technicians. This course prepares students to collaborate effectively in multidisciplinary environments and offers a solid foundation to thrive in the rapidly evolving field of industrial automation

E)   Course Outcomes (COs): After the completion of the course, learners are expected to ensure the accomplishment and attainment of following industry aligned course learning outcomes.

Course Outcomes (COs)	Course Outcome Statements
CAMA05.CO1	Select PLC as per the requirement
CAMA05.CO2	Interface PLC with external hardware.
CAMA05.CO3	Develop PLC programs.
CAMA05.CO4	Maintain PLC systems
CAMA05.CO5	Develop simple automation systems using PLC

F)   Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)				
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/document.	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.	**PO-4** An ability to use modern tools and techniques related to CAD, Manufacturing, and Automation.	**PO-5** An ability to apply optimization techniques to provide a competitive optimal solution to real-world work problems.
CAMA05.CO1	3	-	2	2	-
CAMA05.CO2	3	2	2	2	-
CAMA05.CO3	3	2	3	3	-
CAMA05.CO4	3	2	3	2	-
CAMA05.CO5	2	2	3	2	-

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA05	PCC	PLC and PLC programming	45	15	45	15	120	04	30	70	20	-	20	30	170

H)   Course Curriculum Detailing: For the attainment of course outcomes, the students are expected to perform/ undergo various activities in the classroom, laboratories/ workshops/ term work, and self-learning/ field sessions. As per the requirements of NEP: 2020, unique features like Green skills, Multidisciplinary Aspects, Societal Connect, IKS, and Renewable Energy are integrated appropriately.

I) Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Explain the advantages of PLCs over traditional control systems. *TSO1b.* Compare PLCs with PCs and dedicated controllers. *TSO 1c.* Explain different types of PLCs and their specific use cases. *TSO 1d.* Describe the architecture and components of the given PLC *TSO 1e.* Describe the sequence of operation of the given PLC *TSO 1f.* Explain the benefits and limitations of using PLCs in automation *TSO 1g.* Analyze major PLC brands in the market and their unique features. *TSO 1h.* Describe the potential of integrating AI/ML with PLC systems.	**Unit-1.0 Introduction to PLCs** 1.1 PLC, evolution of PLC, Comparison of PLC and Personal Computer (PC), Comparison of PLC and dedicated controllers like PAC and CNC 1.2 Types of PLC – Fixed, Modular and their types 1.3 Advantages of PLCs over traditional control systems. 1.4 PLC hardware architecture: CPU, I/O modules, communication modules, block diagram of a PLC. 1.5 PLC peripherals and their functions 1.6 Advantages and disadvantages of PLCs. 1.7 Different brands of PLCs available in the market 1.8 Selection criteria for PLCs Real-world applications of PLCs in industries and automation systems likeTraffic light control, Elevator control, Tank level control, temperature control, Conveyor system control 1.9 Emergence of AI/ML in Automation Systems 1.10 Need for intelligent decision-making beyond rule-based logic	**CO1**
TSO 2a. Differentiate between parallel and series communication *TSO 2b.* Explain industrial networking principles and topologies *TSO 2c.* Differentiate RS232, RS422, and RS485 standards for serial communication *TSO 2d.* Implement Ethernet and Fieldbus systems in PLC networks *TSO 2e.* Describe communication protocol used in PLC *TSO 2f.* Describe the steps to configure MODBUS and HART protocol communications *TSO 2g.* Describe the procedure to interface PLC with other given hardware. *TSO 2h.* Explain the procedure to integrate AI/ML algorithms for smart interfacing between PLCs and other hardware components. *TSO 2i.* Design simple communication flows	**Unit-2.0 PLC Communication and Interfacing** 2.1 Analog and Digital Communications on Plant Floors 2.2 Introduction to Industrial Networking 2.3 RS232-422-485 standards for data communication 2.4 Industrial Ethernet 2.5 Concept of Fieldbus 2.6 MODBUS protocol 2.7 Highway Addressable Remote Transducer (HART)Protocol 2.8 Interfacing of Programmable Logic Controller with other hardware 2.9 Communication between PLC and AIML System • Designing interfaces to fetch real-time data from PLCs to the AIML chatbot	**CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
between PLCs and AI/ML systems	• Implementing communication middleware	
TSO 3a. Explain different PLC programming languages with simple examples. TSO 3b. Describe PLC scan cycle in program planning and sequencing TSO 3c. Develop ladder logic program using arithmetic functions to perform the given operation. TSO 3d. Develop ladder logic programs using logical and comparison/convert functions for decision-making processes in control logic. TSO 3e. Develop ladder logic programs in a given PLC to create a delay in operation. TSO 3f. Develop ladder logic programs in a given PLC to count the number of products TSO 3g. Develop program for configuring timers with correct status bit usage. TSO 3h. Develop ladder logic programs for basic applications and simple process automation	**Unit-3.0 PLC Programming** 3.1 PLC programming languages with simple examples: Functional Block Diagram (FBD), Instruction List, Structured text, Sequential Function Chart (SFC), Ladder Programming 3.2 Introduction to PLC programming software (e.g., Siemens TIA Portal, Allen-Bradley RSLogix 3.3 PLC I/O addressing in ladder logic 3.4 PLC programming instructions using ladder logic and relay type instructions 3.5 Program Scan cycle 3.6 PLC arithmetic functions - Addition, subtraction, multiplication, division instructions, increment decrement, trigonometric 3.7 PLC logical functions - AND, OR, XOR, NOT functions, PLC compare and convert functions. 3.8 Programming Timer –Addressing a timer block, status bits, On delay, Off Delay and reset/retentive timer 3.9 Programming Counter- Addressing a counter block, status bits, Up and Down counter, up-down counter, counter examples, register basics.	CO3
TSO 4a. Describe noise mitigation techniques to avoid signal interference and leakage *TSO 4b.* Describe proper grounding techniques. *TSO 4c.* Describe noise reduction techniques *TSO 4d.* Use troubleshooting flowchart for solving hardware and software faults in PLC system step-by-step. *TSO 4e.* Prepare preventive maintenance checklist criteria *TSO 4f.* Interpret diagnostic LED indicators for quick identification of system status and fault areas *TSO 4g.* Explain internal, external and environmental condition in the given PLC system *TSO 4h.* Explain AI-driven troubleshooting method for hardware and software issues.	**Unit-4.0 Installation and Maintenance of PLC Systems** 4.1 PLC enclosure, grounding requirements, noise generating inductive devices, leaky inputs and outputs, techniques to reduce electrical noise and leakage. 4.2 Introduction to PLC Trouble shooting and maintenance, trouble shooting of hardware and software. 4.3 Diagnostic LED Indicators in PLCs 4.4 Common problems • Internal problems – Check for PLC Power Supply, Emergency Push Button, Power Supply Failure, Battery Failure, Electrical Noise Interference, Verify the PLC	CO4

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	Program with the Master Program, Corrupted PLC Memory • External problems - Power failure, faulty grounding and electrical noise interference (RFI or EMI), Status of the Output Modules and their associated Circuitry, Status of the Input Modules and their associated Circuitry, Field Input and Output Devices, Communication Issues. • Environmental Conditions. Check for humidity, temperature, vibration, and noise-level limits specified by its manufacturer 4.5 Troubleshooting of Specific Components of the PLC System • Power Supply Troubleshooting • I/O Modules Troubleshooting • Troubleshooting PLC Program Errors • Troubleshooting the Working Environment of a PLC • Replacement of CPU 4.6 AI-driven expert systems for trouble shooting 4.7 PLC troubleshooting flowchart 4.8 Preventive maintenance, Checklists, preventive maintenance procedure, maintenance plan	
TSO 5a. Explain electrical safety procedures in all PLC related activities. *TSO 5b.* Perform risk assessment to reduce electrical and environmental risks *TSO 5c.* Select appropriate safety equipment for installing and maintaining PLCs *TSO 5d.* Explain the procedure to use AI tools to monitor and enforce workplace safety. *TSO 5e.* Describe the procedure for implementing fail-safe mechanisms in PLC design and operation.	**Unit -5.0 PLC Safety and PPE** 5.1 **PLC Safety Basics** • Common hazards: shocks, unexpected machine start-up • Standards: OSHA, IEC, NFPA 5.2 **Personal Protective Equipment (PPE)** • Gloves, goggles, ESD gear • AI-based PPE detection (e.g., computer vision) 5.3 **Electrical** Safety • Grounding, insulation, voltage testing • Lockout/Tagout (LOTO) procedures 5.4 **Environmental Safety** • Limits for temp, humidity, vibration • AI/IoT sensors for real-time monitoring 5.5 **Software Access Safety**	CO5

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	• User access control • AI for PLC program safety checks 5.6 **Fail-safe & Emergency Systems**-E-stop buttons, safety relays, interlocks, Redundant power and predictive alerts, Risk assessment matrix.	

J) Suggested Laboratory Experiences

Lab Session Outcomes (LSOs)	S. No	Laboratory Experiment Titles	Relevant CO Number(s)
LSO 1.1 Identify the various parts and front panel status indicators of the given PLC. LSO 1.2 Identify different input and output devices that can be connected to the given PLC. LSO 1.3 Test the analog input and output lines of the given PLC. LSO 1.4 Test the digital input and output of the given PLC. LSO 1.5 Use PLC to control the devices like Lamp, Alarm, motor using push button switches	1.	• Identify the various parts and front panel status indicators of the given PLC. • Identify different types of switches and their symbols sensors, lamp, alarm, motor, fan used in a PLC • Identify Analog input and output lines of a PLC • Identify Digital input and output • lines of a PLC • Control various digital and analog output devices	CO1
LSO 2.1 Transfer the control data from PLC to PC and vice versa LSO 2.2 Transfer the control data from PLC to PLC LSO 2.3 Transfer data from sensors to PLC and from PLC to PC. LSO 2.4 Interface the given PLC with a PC or a Laptop	2.	• Establish Data communication from PLC to PC and vice versa • Establish Communication channels • between PLC s. • Establish Data communication from sensor to PLC and from PLC to PC • Interface PLC with a PC or a Laptop	CO2
LSO 2.5 Use machine learning techniques to detect and troubleshoot communication errors.	3.	Anomaly Detection Simulation	CO2
LSO 3.1 Execute Ladder logic program for different arithmetic operations	4.	• Develop ladder logic program for different arithmetic operations.	CO3
LSO 3.2 Execute Ladder logic program for different logical operations such as AND, OR, NOT, NAND, NOR, X-OR, X-NOR gate along with truth table	5.	• Develop ladder logic program for different logical operations • Program Latch and Unlatch circuit in a PLC for motor operation	
LSO 3.3 Program the given PLC to start run and stop the given motor using latch circuit	6.	• Create delay in operation using on delay, off delay and retentive timer	
LSO 3.4 Test the functionality of on delay, off delay and retentive timer for its correct operation in the given PLC.	7.	function in a given PLC for its correct operation	

Lab Session Outcomes (LSOs)	S. No	Laboratory Experiment Titles	Relevant CO Number(s)
LSO 3.5 Test the functionality of Up, Down and Up-down counter in the given PLC	8.	• Count the number of objects/events using Up counter, Down counter and UP/Down counter in a PLC for its correct Operation.	
LSO 3.6 Develop ladder logic program to put LED/lamp in the blinking mode	9.		
LSO 3.7 Develop a ladder logic program to control a simple traffic light control system using PLC	10.	• Program PLC using ladder logic to control an LED/Lamp	
LSO 3.8 Develop a smart irrigation device to detect the change in moisture level in the soil and controls the flow of water accordingly with a DC pump. LSO 3.9 Develop a PLC program to control the robot in such a way that the robot can automatically pick and place components and works in sync with the conveyor belt system. LSO 3.10 Develop a line following robot with RFID sensor for supplying materials and automating workflow. LSO 3.11 Develop smart street light controlling mechanism which will switch on/off the lights automatically depending on the intensity of the sunlight at that particular time of the day.	11.	• Program PLC using ladder logic to control a simple traffic light system • Develop simple automation systems for the given requirement (Select any three from the given list)	
LSO 4.1 Use hygrometer to measure the humidity inside the panel LSO 4.2 Use thermometer to measure ambient temperature inside the panel LSO 4.3 Use tester to determine the voltage fluctuation at the power supply terminals is within specifications LSO 4.4 Test the ground connections of the given PLC. LSO 4.5 The given PLC is not working as per the logic instructions investigate the PLC to identify the cause of failure to show the desired output	12.	Troubleshoot PLC system	CO4
LSO 4.6 Investigate the cause of noise in the given PLC LSO 4.7 PLC goes on blackout out by losing its operating power, troubleshoot the cause of failure. LSO 4.8 Troubleshoot the corrupted PLC memory. LSO 4.9 Replace CPU and power supply fuses in a given PLC system.	13.		
LSO 4.10 Investigate the cause of noise in the given PLC LSO 4.11 PLC goes on blackout out by losing its operating power, troubleshoot the cause of failure. LSO 4.12 Troubleshoot the corrupted PLC memory. LSO 4.13 Replace CPU and power supply fuses in a	14.		

Lab Session Outcomes (LSOs)	S. No	Laboratory Experiment Titles	Relevant CO Number(s)
given PLC system.			
LSO5.1. Perform electrical isolation and prevent accidental energizing	15.	• Lockout/Tagout (LOTO) Procedure on a PLC Panel	CO5
LSO5.2. Select relevant PPE for PLC maintenance.	16.	• PPE Inspection and Compliance Check	
LSO 5.3. Measure grounding resistance at various points. LSO 5.4. Test insulation between live and ground lines.	17.	• Grounding and Insulation Testing • Environmental Monitoring with • Sensors • Emergency Stop Circuit Test	
LSO 5.5. Monitor PLC environment for temperature, humidity and vibration	18.	• AI-Based Safety Audit Simulation • Prepare Safety Checklist	
LSO 5.6. Test the operation and response of an emergency stop (E-STOP) system	19.		
LSO 5.7. Identify safety risks in a PLC setup using an AI tool	20.		
LSO 5.8 Prepare a standard PLC safety checklist.	21.		

K)   Suggested Research Based Problems:

   i.   Integrate traditional PLC systems with modern Internet of Things (IoT) devices to enhance data collection and process automation.
   ii. Evolve strategies that can be implemented to reduce downtime caused by memory corruption in PLCs, and how can data integrity be ensured during power disruptions.
   iii. Design a small PLC-controlled process (e.g., motor, conveyor belt) by integrating an AIML chatbot to provide operational information.
   iv. Develop an AIML-based diagnostic tool that helps operators troubleshoot and repair PLC- based systems

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L)   Suggested Term Work (TW):

    a.   Assignment(s):

- State three advantages of using programmed PLC timer over mechanical timing relay.
- It is required to have a pilot light glow, meeting all of the circuit requirements given below:
  - All four circuit pressure switches must be closed.
  - At least two out of three circuit limit switches must be closed.
  - The reset switch must not be closed.
- Design a logic circuit for the given problem using AND, OR, and NOT gates.
- Prepare a comparison chart of different types of PLC
- Prepare a maintenance plan for a given PLC system.

    b.   Seminar Topics:
- PLC Programming Languages
- Cloud-based PLC programming
- Networking and Integration

M)   Suggested Specification Table for End Semester Theory Assessment (ETA): Questions may be designed based on the higher taxonomy level of cognitive domain.

COs	Relevant Unit Number and Title	Marks
CO1	Unit-1.0 Introduction to PLCs	13
CO2	Unit-2.0 PLC communication and Interfacing	13
CO3	Unit-3.0 PLC Programming	15
CO4	Unit-4.0 Installation and maintenance of PLC systems	15
CO5	Unit -5.0 PLC Safety and PPE	14
Total		**70**

N)   Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT) based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O)   Major Equipment, Tools and Software for Laboratory and Research Work:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experience /Practical Number
1.	Computer system	Processor Intel Core i5, 4 GB RAM, 15 GB free disk space	All
2	Universal PLC Training System with HMI	Universal PLC Training System with HMI (Of reputed make such as Allen bradely, Siemens, etc.,) Compatible with SCADA software	All
3	SCADA software and PLC Software	SCADA software (reputed make like Allen Bradley, Siemens etc.,)	All

P)   Suggested Learning Resources:

a)   Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Advanced PLC Hardware & Programming: Hardware and Software Basics, Advanced Techniques & Allen-Bradley and Siemens Platforms	Frank Lamb	Automation Consulting, 2019 ISBN-13**:** 978-0578482231
2.	PLC Programming 2025 Guide for Beginners: Mastering Industrial	Mezhamier Juohen	Independently published, 2024 ISBN-13: 979-8337680477
	Automation with Step-by-Step PLC Programming Techniques and Real-World Applications	-	-
3.	Mastering PLC Programming: The software engineering survival guide to automation programming Paperback	M. T. White	Packt Publishing Limited, 2023 ISBN-13: 978-1804612880
4.	Industrial Automation Using PLC SCADA & DCS	R.G. Jamkar	Global Education Limited, 2018 ISBN-13: 978-8193579954
5.	Programmable Logic Controllers	Petruzella, F.D.	McGraw Hill India, New Delhi, 2010, ISBN: 9780071067386
6.	Programmable Logic Controller	Jadhav, V. R.	Khanna publishers, New Delhi, 2017, ISBN: 9788174092281
7.	Programmable Logic Controllers and Industrial Automation - An introduction,	Mitra, Madhuchandra, Sengupta, Samarjit,	Penram International Publication, 2015, ISBN: 9788187972174
8.	Supervisory Control and Data Acquisition	Boyar, S. A.	ISA Publication, USA, ISBN: 978-1936007097

b)   Online Educational Resources (OER):

1)   Software: - www.fossee.com

2)   Software: - www.logixpro.com

3)   Software: - www.plctutor.com

4)   Software; -www.ellipse.com

5)   PLC lecture: - https://www.youtube.com/watch?v=pPiXEfBO2qo

6)   PLC tutorial: http://users.isr.ist.utl.pt/~jag/aulas/apil3/docs/API_I_C3_3_ST.pdf

7)   https://www.youtube.com/watch?v=277wwYWolpw-PLC system troubleshooting and repair. Industrial control panel. PLC system repair.

Q)   Course Curriculum Developer

S. No.	Name	E-mail Address
1.	Prof. Vandana Somkuwar	vsomkuwar@nitttrbpl.ac.in

****

A)	**Course Title:** Optimization and Simulation
B)	**Course Code:** CAMA06
C)	**Pre- requisite (s):**

D) Rationale: Optimization techniques are useful finding the optimum solution of a given problem. Optimum solution is a competitive solution in terms of cost or any functional requirement of a system. Hence, solution of any engineering problem is the final solution only when it has gone through a process of optimization, which makes learning of optimization techniques important for any engineering student. The course will cover classical optimization techniques for unconstrained and constrained problems with hands on exercizes related to them.

E) Course Outcomes (Cos): After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
CAMA06.CO1	Formulate an optimum design problem
CAMA06.CO2	Find the optimum solution of single variable unconstrained optimization problems
CAMA06.CO3	Find the optimum solution of multivariable unconstrained optimization problems
CAMA06.CO4	Find the optimum solution of constrained optimization problems
CAMA06.CO5	Find the optimum solution of linear programming problems

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)				
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/docume nt**.**	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	**PO-4** An ability to use modern tools and techniques related to CAD, Manufacturing and Automation	**PO-5** An ability to apply optimization techniques to provide competitive optimal solution to the real world of work problems
CAMA06.CO1	2	2	3	3	3
CAMA06.CO2	2	2	3	3	3
CAMA06.CO3	3	2	3	3	3
CAMA06.CO4	3	2	3	3	3
CAMA06.CO5	3	2	3	2	3

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   Teaching &Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA06	PCC	Optimization and Simulation	45	15	45	15	120	04	30	70	20	-	20	30	170

H)   Course Curriculum Detailing:
For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP: 2020, unique features like Green skills, Multidisciplinary Aspects, Societal Connect, IKS, Renewable Energy are integrated appropriately.

I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Formulate the optimization problem TSO 1b. Classify the optimization problems TSO 1 c. Apply concept of duality.	**Unit-1.0 Introduction to Optimization** 1.1 Optimal design problem formulation 1.2 Classification of the optimization problems 1.3 Concept of duality in optimization 1.4 Examples of optimization problems	**CO1**
TSO 2a. Apply Optimality Criteria for single variable problems TSO 2b. Bracket the optimum solution TSO 2c. Apply direct search methods TSO 2d. Apply gradient based methods	**Unit-2.0 Single Variable unconstrained Optimization** 2.1 Optimality Criteria 2.2 Bracketing methods 2.3. Direct search methods 2.4 Gradient based methods	**CO2**
TSO 3a. Apply Optimality Criteria for Multivariable unconstrained problems …. TSO 3b. Apply direct search methods to find optimal solution TSO 3c. Apply gradient based methods to find optimal solution	**Unit-3.0 Multivariable Unconstrained Optimization** 3.1 Optimality Criteria 3.2 Direct search methods 3.3 Gradient based methods	**CO3**
TSO 4a. Apply Optimality Criteria for Multivariable constrained problems TSO 4b. Apply Transformation methods to find optimal solution TSO 4c. Apply Evolutionary Method to find optimal solution	**Unit- 4.0 Constrained Optimization** 4.1 Optimality Criteria 4.2 Transformation methods 4.3 Evolutionary Optimization method 4.4 Applications	**CO4**
TSO 5a. Find optimal solution to linear programming problem TSO 5b. Apply Simplex method TSO 5c. Apply Dual method	**Unit- 5.0 Linear Programming Problems** 5.1 Linear programming 5.2 simplex method and Dual method 5.3 Applications	**CO5**

J) Suggested Laboratory Experiences:

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number(s)
LSO 1.1 Implement bracketing method using any programming tool LSO 1.2 Formulate a single variable optimization problem	1.	Implement bracketing method using any programming tool and bracket the optimum solution of a single variable problem	CO1, CO2

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number(s)
LSO 1.3 bracket optimum solution of a single variable problem			
LSO 2.1 Implement a direct search method for single variable problem using any programming tool. LSO 2.2 Formulate a single variable optimization problem LSO 2.3. Find optimum solution of the problem.	2.	Implement a direct search method for single variable problem and find the optimum solution of the problem.	CO1, CO2
LSO 3.1 Implement a gradient based search method for single variable problem using any programming tool. LSO 3.2 Formulate a single variable optimization problem LSO 3.3. Find optimum solution of the problem.	3.	Implement a gradient based search method for single variable problem and find the optimum solution of the problem.	CO1, CO2
LSO 4.1 Implement a direct search method for multivariable unconstrained problem using any programming tool. LSO 4.2 Formulate a multivariable unconstrained optimization problem LSO 4.3 Find optimum solution of the problem.	4.	Implement a direct search method for multivariable unconstrained problem and find optimum solution of the problem.	CO1, CO3
LSO 5.1 Implement a gradient based search method for multivariable unconstrained problem using any programming tool. LSO 5.2 Formulate a multivariable unconstrained optimization problem LSO 5.3 Find optimum solution of the problem.	5.	Implement a gradient based search method for multivariable unconstrained problem and find optimum solution of the problem.	CO1, CO3
LSO 6.1 Implement a transformation method for constrained optimization problem using any programming tool. LSO 6.2 Formulate a constrained optimization problem LSO 6.3 Find optimum solution of the problem.	6.	Implement a transformation method for constrained optimization problem and find optimum solution of the problem.	CO1, CO4
LSO 7.1 Implement an evolutionary method for constrained optimization problem using any programming tool. LSO 7.2 Formulate a constrained optimization problem LSO 7.3 Find optimum solution of the problem.	7.	Implement an evolutionary method for constrained optimization problem and find optimum solution of the problem.	CO1, CO4
LSO 8.1 Implement Simplex method for linear programming problem using any programming tool. LSO 8.2 Formulate a linear programming problem LSO 8.3 Find optimum solution of the problem.	8	Implement Simplex method for linear programming problem and find optimum solution of the problem.	CO1, CO5

K) **Suggested Research Based Problems**

   i.   Trucks are subjected to impact from the front side. Design FUPD of truck made of FRCP composite with optimum parameters.
   ii.   Gear box has a number of gears on multiple shafts. Find Optimum material configuration for gear box for reduction of speed in ratio   1:10

Note: Depending on the requirement of each laboratory experience, micro project and research based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L) **Suggested Term Work (TW):**

   a.   Assignment(s):

   Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

   b.   Seminar Topics:

   - Classical optimization methods Vs modern optimization methods
   - Multi-objective optimization
   - 1D minimization
   - Unconstraint Vs Constraint Optimization

M) **Suggested Specification Table for End Semester Theory Assessment (ETA):** Questions may be designed based on the higher taxonomy level of cognitive domain.

COs	Relevant Unit Number	Marks
CO1	Unit 1.0 Introduction to Optimization	10
CO2	Unit 2.0 Single Variable Unconstrained Optimization	14
CO3	Unit-3.0 Multivariable Unconstrained	15
CO4	Unit- 4.0 Constrained Optimization	15
CO5	Unit- 5.0 Linear Programming Problems	16
Total		**70**

N) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT) based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O)   **Major Equipment, Tools and Software for Laboratory and Research Work:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experience /Practical Number
1.	Computer systems	Processor Intel Core i9, 64 GB RAM, 64 bit OS, Graphic card 64GB, Storage 2.75 TB	1 - 8
2.	Matlab	Matlab Release R2024b	1 - 8
3	Simcentre 3D	Siemens Modeling and Optimization Module	7

P)   **Suggested Learning Resources:**

a) **Books**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Optimization for Engineering Design	Kalyanmoy Deb	2nd Edition, Prentice Hall of India, ISBN 9788120346789
2.	Introduction to Optimum Design	J. S. Arora	4th Edition, Elsevier, ISBN 978-0-12-800806-5
3.	Engineering Optimization Theory and Practice	Singiresu S Rao	John Wiley & Sons, ISBN:9781119454717
4.	Linear Programming and Extensions	G.B. Dantzig	3rd ed, Princeton University Press, ISBN: 0691080003
5.	Non-Linear Optimization - Theory and Algorithms	L.C.W. Dixon	Birkhauser, Boston, ISBN: 9783764330200

b) **Online Educational Resources:**

1) https://archive.nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L1slides.pdf
2) https://www.sciencedirect.com/book/9780128211267/fundamentals-of-optimization-techniques-with-algorithms

Q)   **Course Curriculum Developer**

S. No.	Name and Designation	E-mail Address
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****

A)	**Course Title:** Introduction to Robotics
B)	**Course Code:** CAMA07
C)	**NPTEL course -** **https://nptel.ac.in/courses/112104298** **Introduction to Robotics by Prof Ashish Dutta**

D)   Rationale: A robotics curriculum equips students with essential 21st-century skills by integrating STEM concepts through hands-on, interdisciplinary learning. It enhances problem-solving, creativity, and technological literacy while fostering interest in careers like automation and AI. By connecting theory to real-world applications, robotics prepares students to navigate and shape a rapidly evolving technological future.

E)   Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of the following industry-expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
CAMA07.CO1	Classify robots
CAMA07.CO2	Compute the movement of a robot using kinematic equations
CAMA07.CO3	Predict the performance of robotic systems
CAMA07.CO4	Apply control techniques to guide robot behaviour

F)   Suggested Course Articulation Matrix (CAM): (Not Applicable)

G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA07	PEC	Introduction to Robotics	-	-	-	-	-	03	-	-	-	-	-	-	100

H) **Course Curriculum Detailing:** For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, and renewable energy are integrated appropriately.

I) **Theory Session Outcomes (TSOs) and Units:**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Explain robotics concepts, types, and their components *TSO 1b.* Classify different types of robots. *TSO 1c.* Explain key components of robotic systems. *TSO 1d.* Describe the function and structure of a given robot *TSO 1e.* Explain work volume of the given robot	**Unit 1.0 Introduction to Robots** 1.1 History and evolution of robotics 1.2 Definition and classification of robots 1.3 Types of robots (industrial, service, mobile, humanoid, etc.) 1.4 Types of robot joints- cylindrical, revolute, prismatic and spherical; degrees of freedom (DOF) of various robots. Work volume of robots	CO1

TSO 2a. Explain the concepts of forward and inverse kinematics.
TSO 2b. Solve Forward kinematics (FK) problems for simple manipulators.
TSO 2c. Analyze robot workspace and motion constraints.
TSO 2d. Calculate the position and orientation of a robot's end-effector using forward kinematics
TSO 2e. Explain the steps to model a basic robot arm in simulation software using transformation matrices and DH parameters.
TSO 2f. Explain the relationship between joint variables and task space using simple robotic models.
	Unit 2.0 Robot Kinematics
	
	2.1 Coordinate transformations
	  • Spatial transformation
	  • homogeneous transforms
	2.2 Denavit–Hartenberg (DH) parameters
	2.3 Derivation of Link Transformations
	2.4 Forward kinematics (FK) for 2-DOF and 3-DOF manipulators
	2.5 Inverse kinematics (IK) of robotic manipulator arms
	2.6 Inverse Kinematics of PUMA Robot
	2.7 Jacobian and Singularity
	2.8 Workspace and reachability analysis
		CO2

TSO.3a Describe forces and torques involved in robotic motion. *TSO.3b* Use Newton-Euler or Lagrangian methods to compute required joint torques in a simple robotic manipulator. *TSO.3c* Predict robot movement under external loads or varying joint accelerations *TSO.3d* Explain how forces and torques affect robotic motion. *TSO.3e* Analyze the dynamic behaviour of a given robotic manipulator.	**Unit3.0 Robot Dynamics** 3.1 Velocity and Static Forces 3.2 Newton-Euler and Lagrangian approaches 3.3 Trajectory Planning 3.4 Joint torques, inertia, and Coriolis effects 3.5 Inverse Dynamics using MATLAB	CO3

Major Theory Session Outcomes (TSOs)		Units	Relevant CO Number(s)
TSO.3f	Interpret the effects of inertia, gravity, and Coriolis forces in robotic systems		
TSO.4a	Differentiate between open-loop and closed-loop control systems.	**Unit 4: Control of Robotic Systems**	**CO4**
TSO.4b	Explain sensor-based feedback to achieve motion control.	4.1 Open-loop vs. closed-loop control, conditionals, variables	
TSO.4c	Develop control algorithms for trajectory following and positioning.	4.2 Sensors different types of sensors and their uses in robots, Feedback systems using sensors (encoders, gyros, vision)	
TSO.4d	Explain closed-loop control system that responds to real-time sensor feedback.	4.3 Actuators and Basic Control System	
TSO.4e	Develop control algorithms in a robot to follow a specific trajectory or path.	4.4 Block Diagram Reduction and Position Regulator	
		4.5 Control of a single joint	
		4.6 Non-Linear Control of Manipulators	
		4.7 Force Control	
		4.8 Manipulator Mechanism Design	
		4.9 Industrial Robots and Applications	
		4.10 Specifications and Programming	
		4.11 VAL programming	
		4.12 Experiment with PUMA Robot Using VAL-II	

J)   **Suggested Laboratory Experiences:** (Not Applicable)

K)   **Suggested Research Based Problems:** (Not Applicable)

L)   **Suggested Term Work (TW):** (Not Applicable)

M)   **Suggested Specification Table for End Semester Theory Assessment (ETA):** (Not Applicable)

N)   **Suggested Instructional/Implementation Strategies:** (Not Applicable)

O)   **Equipment, Tools and Software for Laboratory and Research Work:** (Not Applicable)

P)   **Suggested Learning Resources:** (Not Applicable)

Q)   **Course Curriculum Developer**

S. No.	Name	E-mail Address
1.	Prof. Vandana Somkuwar	vsomkuwar@nitttrbpl.ac.in

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A)	**Course Title:** Design & Implementation of Human-Computer Interfaces
B)	**Course Code:** CAMA08
C)	**NPTEL course -** https://onlinecourses.nptel.ac.in/noc22_cs125/preview **Prof. Samit Bhattacharya, IIT Guwahati**

D) **Rationale:** With the rapid growth of consumer electronic products, Human-Computer Interfaces (HCI) have become integral to everyday life. Ensuring that these systems are usable by non-expert users is a key challenge in modern design. This course focuses on the principles and process of creating usable systems through systematic stages, ranging from identifying usability requirements to design, implementation, and evaluation. Students will learn usability engineering concepts, user-centered design methods, and techniques for transforming designs into practical information systems. The course aims to equip learners with the skills needed to design intuitive and effective user interfaces.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of the following industry-expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
CAMA08.CO1	Explain the Fundamentals of Human-Computer Interfaces and Usability
CAMA08.CO2	Analyze Usability Requirements for Different Consumer Electronic Products
CAMA08.CO3	Apply fundamental concepts of usable design to develop a user-centric system
CAMA08.CO4	Evaluate the usability of designs and implementations using appropriate methods

F) **Suggested Course Articulation Matrix (CAM):** (Not Applicable)

G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		Total Marks (TA+TWA+LA)
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA08	PEC	Design & Implementation of Human-Computer Interfaces	-	-	-	-	-	03	-	-	-	-	-	-	100

H)   Course Curriculum Detailing:
For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, and renewable energy are integrated appropriately.

I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Analyze the concept and significance of Human-Computer Interfaces (HCI) in modern systems. TSO 1b. Identify key usability factors and challenges in system design. TSO 1c. Analyze user needs to determine usability requirements for interface design.	**Unit 1.0 Introduction and Identification of Usability Requirements** 1.1 Definition and scope of Human-Computer Interfaces (HCI) 1.2 Importance of usability in modern digital systems 1.3 Overview of usability engineering process 1.4 Deriving functional and usability requirements 1.5 Prioritizing usability goals	CO1
TSO 2a. Apply principles of usable interface design to develop user-centered systems. TSO 2b. Recognize the role of consistency, feedback, and visual clarity in interface usability.	**Unit 2.0 Usable Interface Design & Evaluation** 2.1 Principles of usable interface design (consistency, feedback, simplicity) 2.2 Layouts, navigation, and information architecture	CO2

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 2c. Conduct rapid usability evaluation techniques to assess design effectiveness. TSO 2d. Interpret early evaluation results to improve interface prototypes.	2.3 Affordances and constraints in interface design 2.4 Heuristic evaluation techniques 2.5 Tools and checklists for early usability assessment	
TSO.3a Translate usability-focused interface designs into system architecture. TSO.3b Evaluate the feasibility and scalability of converting designs into interactive systems. TSO.3c Apply software tools and frameworks for interface development. TSO.3d Address challenges in mapping user workflows into functional system components.	**Unit3.0 Converting Design to System** 3.1 Low-fidelity vs high-fidelity prototyping 3.2 Interface development tools and technologies. 3.3 Interaction flows and dynamic content rendering 3.4 Linking interface components with system logic 3.5 Prototype usability testing	CO3
TSO.4a Implement human-computer interfaces based on structured usability design. TSO.4b Integrate front-end and back-end components effectively during development. TSO.4c Apply programming best practices for responsive and interactive systems. TSO.4d Resolve implementation-level usability issues through iterative development TSO.4e Conduct empirical evaluations to assess the usability of implemented systems. TSO.4f Analyze user feedback and performance data to measure interface effectiveness. TSO.4g Recommend improvements based on usability evaluation outcomes.	**Unit 4.0: System Implementation and Usability Evaluation** 4.1 Software development life cycle for HCI 4.2 UI frameworks and libraries overview 4.3 Backend integration with UI components 4.4 Data flow and state management in UI 4.5 Multi-device and multi-platform compatibility 4.6 Types of empirical evaluation: lab-based, remote, field studies 4.7 Experimental design and metrics: efficiency, effectiveness, satisfaction 4.8 Review of the HCI design and implementation process 4.9 Emerging trends in HCI	CO4

J)   **Suggested Laboratory Experiences:** (Not Applicable)

K)   **Suggested Research Based Problems:** (Not Applicable)

L)   **Suggested Term Work (TW):** (Not Applicable)

M)   **Suggested Specification Table for End Semester Theory Assessment (ETA):** (Not Applicable)

N)   **Suggested Instructional/Implementation Strategies:** (Not Applicable)

O)   Equipment, Tools and Software for Laboratory and Research Work: (Not Applicable)

P)   Suggested Learning Resources:

a)   **Books**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Human-Computer Interaction: User-Centric Computing for Design.	Samit Bhattacharya.	McGraw Hill Education (1st ed). (2019).
2	Software Engineering: A Practitioner's Approach.	Bruce R Maxim & Roger S Pressman	McGraw Hill Education ((8th ed). 2019).

b)   **Online Educational Resources**

1)   https://www.edx.org/

2)   https://ocw.mit.edu/

3)   https://www.udacity.com/

Q)   Course Curriculum Development Team

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A)	**Course Title:** System Design for Sustainability
B)	**Course Code:** CAMA09
C)	**NPTEL course -** https://onlinecourses.nptel.ac.in/noc19_de03/preview **Prof. Prof.Sharmistha Banerjee, IIT Guwahati**

D)   Rationale: In the face of escalating environmental challenges, resource depletion, and climate change, designing systems that prioritize sustainability has become not only a moral imperative but also a strategic necessity. Design for Sustainability is a design thinking process for widening the boundaries of the objective of design so as to contribute positively to sustainable development. It encompasses four approaches: 1. Selection of resources with low environmental impact; 2. Design of products with low environmental impact; 3. Product-Service System Design for eco-efficiency; 4. Design for social equity and cohesion. This course will discuss these Design approaches, methods and tools along with case examples. By exploring sustainable system design, students and professionals gain the tools to develop innovative solutions that contribute to long-term ecological balance and human well-being.

E)   Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course out comes by the learners.

Course Outcomes (COs)	Course Outcome Statements
CAMA09.CO1	Analyze evolution of sustainability with in the domain of design
CAMA09.CO2	Analyze product life-cycle design for sustainability
CAMA09.CO3	Analyze sustainability and sustainable development
CAMA09.CO4	Design products and services to take care world towards sustainable development.

F)   Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)				
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/document.	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	**PO-4** An ability to use modern tools and techniques related to CAD, Manufacturing and Automation.	**PO-5** An ability to apply optimization techniques to provide competitive optimal solution to the real world of work problems.
CO1	2	3	-	-	-
CO2	-	2	-	-	2
CO3	-	-	3	-	2
CO4	-	-	3	-	3

Legend: **High (3), Medium (2), Low (1) and No mapping (-)**

G) Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		Total Marks (TA+TWA+LA)
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
CAMA09	PEC	System Design for Sustainability	-	-	-	-	-	03	-	-	-	-	-	-	100

H) Course Curriculum Detailing:
For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

I) Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Analyze evolution of sustainability with in the domain of design	**Unit-1.0 Basics of sustainability** 1.1 What is sustainability, sustainable development? 1.2 Why do we need sustainable development? 1.3 Evolution of sustainability within Design.	**CO1**
TSO 2a. Analyze product life-cycle design for sustainability	**Unit-2.0 Product Life Cycle Design** 2.1 Methods & Strategies 2.2 Software Tools	**CO2**
TSO 3a. Analyze sustainability and sustainable development	**Unit-3.0 Sustainable Product-Service System Design** 3.1 Definition 3.2 Types	**CO3**
TSO 4a. Analyze sustainability and sustainable development	**Unit-4.0 Sustainable Product-Service System** 4.1 Transition Path	**CO3**

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Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	4.2 Challenges	
TSO 5a. Design products and services to take care world towards sustainable development.	**Unit-5.0 Designing for Sustainable Product-Service System** 5.1 Methods 5.2 Tools 5.3 Other Design for Sustainability Tools and approaches.	**CO4**
TSO 6a. Design products and services to take care world towards sustainable	**Unit-6.0 Design for Sustainability** 6.1 Engineering Design Criteria 6.2 Engineering Design Guidelines 6.3 Summary - Connecting the threads	**CO4**

J) Suggested Laboratory Experiences: (Not Applicable)

K) Suggested Research Based Problems: (Not Applicable)

L) Suggested Term Work (TW): (Not Applicable)

M) Suggested Specification Table for End Semester Theory Assessment (ETA): (Not Applicable)

N) Suggested Instructional/ Implementation Strategies: (Not Applicable)

O) Major Equipment, Tools and Software for Laboratory and Research Work:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experience /Practical Number
1.	Computer system	Processor Intel Core i5, 4 GB RAM, 15 GB free disk space	All

P) Suggested Learning Resources:
   a) Books

S. No.	Titles	Author(s)	Publisher and Edition withISBN
1.	Product-service system design for sustainability	Vezzoli, C., Kohtala, C., Srinivasan, A., Xin, L., Fusakul, M., Sateesh, D. and Diehl, J.C.	Routledge, ISBN 9781906093679
2.	Designing for Sustainability	Tim Frick	O'Reilly Media, Inc. ISBN: 9781491935729
3.	Design for Environmental Sustainability	Carlo Vezzoli, Ezio Manzini	Springer London ISBN: 978-1-84800-163-3

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S. No.	Titles	Author(s)	Publisher and Edition withISBN
4.	Design for Environment: A Guide to Sustainable Product Development	Joseph Fiksel	McGraw-Hill Education ISBN: 9780071605564

b) Online Educational Resources (OER):

1) https://onlinecourses.nptel.ac.in/noc25_de21/preview

Q)   Course Curriculum Development Team

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A)	**Course Title:** Project
B)	**Course Code:** PD01
C)	**Pre- requisite (s):**

1. Rationale:
The national policy on education has made provision for the implementation of outcome-based education, the design of imaginative curriculum, use of engaging pedagogy and formative assessment to assure the quality of education. The project-based instructional method is a learner-centric method that develops higher-order learning skills such as creative skills, critical thinking, investigative skills, analytical skills, entrepreneurship skills, incubation skills, communication skills and collaboration skills as mentioned in the NEP 2020. The project-based learning is systematically planned and implemented at the institute level across the programmes to exploit its full potential for learning. A guideline for managing and assessing the learners' project work is prepared to make all the stakeholders aware and educate them to assure quality learning through project work, make the process transparent and relevant.

2. Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
PD01	PD	Project	-	-	45	105	150	05	-	-	200	-	-	-	200

3. Broad guidelines for major project work
- The project's problems/themes/ should be relevant to current issues and practices of the industry/society.
- The project should address the majority of the outcomes at the programme level.
- Provision for self-assessment, assessment by teacher/expert should be incorporated to improve the quality of the project work and ensure a higher level of learning aligned to programme level outcomes.
- Provision to showcase a learning portfolio as a project output.
- The learners should be encouraged to publish the work (in the form of a paper, newspaper item, case study, report, etc.) after getting approval from the guide and the organization where the project is completed.

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- The learners should submit the plagiarism check report during the final submission.
- Learners should record the output/ periodic achievements of significant interactions, feedback, discussions, and events at different milestones using a logbook.
- The schedule for project work is mentioned in table 1.
- The learners will be assessed during different stages of the project as per the rubrics mentioned in table 2.
- The project proposal and the report are to be prepared as per format 1 and format 2, respectively.

Table-1

4. Schedule of the Project work

S. No	Activities	Target Duration	Responsibility	Formative Assessment Marks Weightage	Output Expected
1.	**Conducting Orientation** • Rationale of the project • Credit of the project • Marks of the project • Expectations related to quality of project work • Road map of the project work	Week I	Dept. Team		
2.	**Stage 1: Project Planning**	Week II		20	
	• Preparation of synopsis/project proposal • Identification of project problem/theme • Interaction with the industry/organization resource person • Literature review • Tentative topic • Presentation and feedback (within department) • Finalization of topic • Preparation of project proposal/synopsis (as per format 1)				Draft Project Proposed
	• Presentation and assessment of project proposal • Approval of project proposal	Week IV	Dept. Team Using Rubric 1		Approved Project Proposal
3.	**Stage 2: Execution of Project Work as per the Project Proposal**	Week V		30	
	Execution of project work as per the action plan				
	Monitoring and assessment of progress and sharing of experience	Week VIII			
	Monitoring and assessment of progress and sharing of experience	Week XII			
4.	**Stage 3: Project Report Submission and Presentation**				
	Submission of draft report	Week XIV		20	Draft Report

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S. No	Activities	Target Duration	Responsibility	Formative Assessment Marks Weightage	Output Expected
	• Presentation of draft project report • Internal assessment and review		Dept. Team		
	• Final submission • Presentation and assessment	Week XVI	Dept. Team and Expert		Final Project Report
	Submission of Report				

Format 1

Project Proposal

1. **Name of the Programme:**
2. **Broad Area/Theme of the Project:**
3. **Title of the Project:**
4. **Rationale:**
5. **Objectives:**
6. **Scope of the Project:**
7. **Project Outcomes:**

   i. Carry out research /investigation independently
   ii. Demonstrate a degree of mastery in areas of specialization and research
   iii. Use alternative strategies/methods
   iv. Demonstrate innovative abilities
   v. Exhibit project management abilities
   vi. Develop sustainable, environmentally and society-friendly output
   vii. Demonstrate lifelong learning skills, learning-to-learn skills, and self-learning skills
   viii. Adhere to professional ethics and values
   ix. Write a technical project report
   x. Defend project work

8. **Action Plan:**
9. **Literature Survey:**
10. **Proposed Methodology:**

    i. Resources required
    ii. Test
    iii. Sampling
    iv. Method
    v. Model
    vi. Any other (please specify)

11. **References:**
12. **Project Future Potential:**

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Table 2

5. Assessment Rubrics for Project Work

S. No.	Criterion	Very Good (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
1.	**Project Planning** Outcome: Plan the Project Effectively				
1.1	**Rationale**	Clear and well-articulated. Strong justification based on real-world problems.	Depicts understanding of the background and purpose with some connection to practical or academic needs.	Rationale is stated but lacks depth or clarity. Justification is weak or only partially connected to real world problems.	Rationale is unclear. Fails to justify the need or relevance of the project.
1.2	**Literature Survey**	Comprehensive, well-structured review of relevant and up-to-date literature.	Adequate review covering relevant literature. Shows a good understanding of the topic.	Basic literature review with limited relevance or scope. Shows minimal understanding of the subject area.	Inadequate or poorly organized literature review. Sources are outdated, irrelevant, or insufficient.
1.3	**Outcome Proposed**	Proposed outcomes are well defined, realistic, and highly relevant to the problem statement.	Outcomes are adequately-stated and relevant to the problem statement.	Outcomes are defined but lack clarity. They are somewhat relevant but are vague.	Outcomes are poorly defined. They lack relevance to the problem statement.
2.	**Project Execution** Outcome: Execute the project as per the laid-down criteria				
2.1	**Appropriateness of the Methodology Adopted**	Methodology is highly appropriate and clearly aligned with project problem. Demonstrates deep understanding and use of tools/ techniques/ procedures.	Methodology is suitably aligned with the project problem. Shows good understanding and use of tools/ techniques/ procedures.	Methodology is somewhat appropriate but lack clarity or alignment with project problem. Shows basic understanding and use of tools/ techniques/ procedures.	Methodology is inappropriate, poorly explained. Shows little understanding and use of tools/ techniques/ procedures.
2.2	**Feasibility of Solution**	The proposed solution is highly feasible with clear consideration of time, resources, skills and constraints. Execution is practical.	The proposed solution is generally feasible with minor limitations. Resources and timelines are mostly considered. Some adjustments are needed for the project to be practical.	The proposed solution is partially feasible but shows gaps in planning or resource estimation. Face challenges in execution.	The proposed solution is not feasible due to unrealistic assumptions and poor planning. Execution appears impractical.
2.3	**Newness of the Project Work**	Project demonstrates high originality or innovation. Introduces a novel concept, approach, or solution that is significant different from existing work.	Project shows some originality. Modifies or improves existing ideas or solutions in a meaningful way. Offers partial innovation.	Project has limited newness. Mostly based on existing ideas with minor adjustments. Lacks significant innovation.	Project lacks originality. Direct replication of existing work with no new contribution.

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S. No.	Criterion	Very Good (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
2.4	Resourcefulness	Demonstrates exceptional initiativeness and creativity in utilizing/arranging resources effectively.	Shows good use of resources and tools. Demonstrate moderate initiativeness and creativity in utilizing/ arranging resources.	Makes basic use of resources with limited initiative. Relies heavily on guidance.	Shows poor ability of utilizing/arranging resources.
2.5	Sustainability	Project demonstrates strong sustainability considering all aspects like- environmental, economic, and social impacts.	Project demonstrates moderate sustainability practices considering some aspects like- environmental, economic, and social impacts.	Project demonstrates limited sustainability practices considering some aspects like- environmental, economic, and social impacts.	Project lacks sustainability considerations.
2.6	Maintaining Daily Diary or Log Book	Diary/log book is consistently and meticulously maintained. Entries are detailed, dated, and clearly reflect daily progress.	Diary/log book is periodically maintained with relevant entries. Most entries are dated and show a good record of activities and progress.	Diary/log book is maintained irregularly. Entries are brief or lack detail.	Diary/log book is poorly maintained or mostly incomplete. Important entries are missing or unclear.
3.	**Quality of Product/Process** **Outcome:** Ensure the Quality of Product/Process				
3.1	Originality of Product	The final product is original and creative. It presents unique features, functions, or designs not found in existing solutions.	The final product is somewhat original with some creative elements or improvements over existing ideas.	The product has limited originality. Mostly based on existing ideas or minor modifications.	The product lacks originality. It is a direct reproduction of existing work with no new features or creative input.
3.2	Cost Effectiveness of Product/Process	Process and/ product are highly cost-effective. Optimal use of resources. Demonstrates strong value-for-money.	Process and/ product are reasonably cost-effective. Resources are mostly used wisely, with acceptable cost.	Process and/ product show limited cost-effectiveness.	Process and/ product are not cost-effective. Inefficient use of resources.
3.3	Proposed Outcomes Achieved	All proposed outcomes are fully achieved.	Most of the proposed outcomes are achieved with satisfactory quality.	Some proposed outcomes are achieved with minor gaps.	A few or none of the proposed outcomes are achieved.
4.	**Project Report Writing** **Outcome:** Write Quality Project Report				
4.1	Style and Language	Language is clear, precise, and academically appropriate throughout. Style is formal, consistent, and well-suited,	Language is generally clear and appropriate. Style is mostly formal and consistent. The quality of the	Language is understandable, but is informal. Style occasionally deviates from the formal standards. The	Language is unclear, informal, or inappropriate for a technical report. Style is inconsistent and affects the quality of the report.

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S. No.	Criterion	Very Good (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
		hence enhancing the overall quality of the report.	report is acceptable.	quality of the report is moderate	
4.2	**Quality of Related Diagrams/Dra wings/Graphs in Project Report**	Diagrams/ drawings/ graphs are highly relevant, accurate, well-labelled and neatly presented.	Diagrams/ drawings/ graphs are mostly accurate, clear, and mostly relevant to the content. Properly labelled and adequately formatted.	Diagrams/ drawings/ graphs are present but lack clarity, proper labelling, or relevance.	Diagrams/ drawings/ graphs are missing/ incorrect, or poorly presented.
4.3	**Future Scope of Project**	Demonstrates deep insight into how the project can be expanded/ improved/ applied in broader contexts.	Demonstrates awareness of how the project can be expanded/ improved/ applied in broader context, though some aspects may need more depth	Limited insight into how the project could be developed further.	No clear future scope identified or missing. Lacks understanding of how the project could be extended or applied further.
5.	**Quality of Presentation** **Outcome**: Demonstrate Good Presentation Skills				
5.1	**Comprehensi on of Concepts, Design and Methodology**	Demonstrates thorough understanding of underlying concepts, design and methodology.	Demonstrates good understanding of underlying concepts, design and methodology with minor gaps.	Demonstrates basic understanding of underlying concepts, design and methodology, but explanations are limited or partially correct with misconceptions developed.	Demonstrate poor or insufficient understanding of underlying concepts, design and methodology. Unable to explain or justify the approach clearly.
5.2	**Communicati on Skills**	Communicates ideas with exceptional clarity, fluency, and confidence. Language is precise and professional. Engages the audience effectively. Actively listens and responds thoughtfully.	Communicates clearly and confidently with minor lapses. Language is appropriate, and ideas are conveyed well. Demonstrate good listening skills.	Communicates basic ideas but with occasional lack of clarity or fluency. May struggle with appropriate vocabulary or organization of thoughts. Demonstrate fair listening skills.	Struggles to communicate ideas clearly. Lacks fluency, coherence, or appropriate vocabulary. Responses are unclear or incorrect. Poor listening and interaction with audience.
5.3	**Slide Organization**	Slides are visually appealing, well-organized, and professionally designed. Content is concise, relevant, and supports verbal presentation effectively. Excellent use of visuals (e.g., graphs, images,	Slides are well-structured. Content is mostly relevant and supports the spoken presentation. Visuals are used appropriately. Minor issues in font size, colour, and layout.	Slides have a basic structure but are cluttered. Lack proper visual support. Too much of text. Font size and colour is not appealing.	Slides are poorly designed or difficult to read. Content is disorganized, excessive, or irrelevant. Visuals are missing or irrelevant. Font size and colour are poor.

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S. No.	Criterion	Very Good (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
		icons). Fonts, size, colours, and layout enhance readability.			
5.4	Ability to Defend Questions	Responds to all questions confidently, accurately and with deep understanding and proper justifications.	Responds to most questions correctly and confidently. Demonstrates good understanding with minor gaps in Justifications.	Responds to basic questions with partial accuracy. Shows limited understanding with weak justifications.	Unable to answer questions clearly or correctly. Responses reflect poor understanding.

Format 2

Project Report

1. **Name of the Programme:**
2. **Broad Area/Theme of the Project:**
3. **Title of the Project:**
4. **Rationale:**
5. **Objectives:**
6. **Scope of the Project:**
7. **Literature Survey:**
8. **Methodology used (as applicable):**
   i. Resources used
   ii. Test
   iii. Sampling
   iv. Method
   v. Model
   vi. Any other (please specify)
9. **Observation, Analysis, and Interpretation:**
10. **Reporting of Results and Conclusion:**
11. **Project Future Potential:**
12. **References:**
13. **Bibliography:**
14. **Annexure (as applicable):**

D) Course Curriculum Development Team

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Course Curriculum Detailing- Online Spell -1

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A)	**Course Title:** Research Methodology
B)	**Course Code:** PC01
C)	**Pre- requisite (s):**

D) **Rationale:** This course deals with the principles of research and significant phases of research using realistic plans to be followed. After completing the course, the researcher can choose the research field, research topic and formulate the research problem. The research methodology course provides an idea of literature review, critical thinking and logical reasoning, designing experiments, data analysis and interpretation, thesis writing, scientific writing, and presentation skills. The need, therefore, is for those concerned with research to pay due attention to designing and adhering to the appropriate methodology to improve the quality of research. The course emphasizes the principles of effective research and the need for a proactive approach in a successful research program. The researchers will get an insight into the privilege, honour, and associated research responsibilities.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
PC01.CO1	Explain the basic concepts of research
PC01.CO2	Review the relevant literature effectively and efficiently
PC01.CO3	Make use of the guidelines to progress from the choice of the broad field of research to a specific topic of research
PC01.CO4	Apply critical thinking and analytical thinking in research methodology
PC01.CO5	Analyze well-structured research proposals and research papers invoking clearly outlined principles

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F)   **Suggested Course Articulation Matrix (CAM):**

Course Outcomes (COs)	Programme Outcomes (POs)		
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/document.	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PC01.CO1	3	3	2
PC01.CO2	3	3	2
PC01.CO3	3	-	3
PC01.CO4	3	-	3
PC01.CO5	3	1	3

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   **Teaching & Learning and Assessment Scheme:**

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
PC01	PC	Research Methodology	30	-	-	30	60	02	30	50	20	-	-	-	100

H)   **Course Curriculum Detailing:** For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

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I) Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Explain the History and Evolution of research and innovation *TSO 1b.* Classify the different types of research *TSO 1c.* Describe the step involved in the research *TSO 1d.* Explain the Relevance of Research for Innovation, Technology Development, and social relevance *TSO 1e.* State the importance of Hypotheses in Research	**Unit-1.0 Basic Concepts of Research** 1.1 History and Evolution of research and innovation 1.2 Types of Research 1.3 Research innovation and social relevance 1.4 Mandatory Steps in Research 1.5 Relevance of Research for Innovation and Technology Development 1.6 Importance of Hypotheses in Research	**CO1**
TSO 2a. Describe the Importance of Literature Review *TSO 2b.* Present a comprehensive overview of relevant research and theories on the topic *TSO 2c.* Apply strategies for good Literature Search *TSO 2d.* Organize Referencing Ethics, Paraphrasing, and Summarizing *TSO 2e.* Make use of literature review tools	**Unit-2.0 Literature Review** 2.1 Importance of Literature Review 2.2 Characteristics of Good Literature Review 2.3 Review and Strategies for Good Literature Search 2.4 Referencing Ethics, Paraphrasing and Summarizing 2.5 Tools for literature review	**CO2**
TSO 3a. Classify the data types for analysis *TSO 3b.* Design experiments *TSO 3c.* Describe the methods of data collection *TSO 3d.* Draw valid conclusions from sampling methods, statistical analysis *TSO 3e.* Identify the Research problem *TSO 3f.* Demonstrate narrowing down the problem *TSO 3g.* List the Factors to be considered for the selection of the problem	**Unit-3.0 Research Problem Formulation** 3.1 Data collection, data analysis, data types, and interpretation 3.2 Designing of Experiments 3.3 Methods of data collection 3.4 Sampling methods, statistical analysis, and displaying of data 3.5 Research problem identification 3.6 Narrowing down the problem 3.7 Factors to be considered for the selection of the problem	**CO3**
TSO 4a. Construct Out of the Box Thinking problem *TSO 4b.* Interpret Transformation to Impossible Thinking *TSO 4c.* Distinguish Convergent and Divergent Thinking *TSO 4d.* Evaluate the selection of idea *TSO 4e.* Evaluate the line of reason for thinking critically *TSO 4f.* Compare Critical and Analytical Thinking in Research Methodology	**Unit-4.0 Critical and Analytical Thinking** 4.1 Out-of-Box Thinking 4.2 Transformation to Impossible Thinking 4.3 Convergent and Divergent Thinking 4.4 Generation, Evaluation, and Selection of Ideas 4.5 Critical thinking 4.6 Comparison of Critical and Analytical Thinking	**CO4**
TSO 5a. Illustrate the Structure of a Good Research Proposal *TSO 5b.* Write good research proposal	**Unit -5.0 Research Proposal**	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 5c. List the tips for compilation *TSO 5d.* Classify the types of scientific report *TSO 5e.* Develop structure and components of the conference *TSO 5f.* Write the report with ethics and scientific conduct *TSO 5g.* Analyze the presenting work is from another source with or without consent of the original author	5.7 Getting Started to Write a Research Proposal 5.8 Tips for Compilation 5.9 Scientific writing: types of scientific report 5.10 Structure and components of a conference 5.11 Arts of writing, ethics, and scientific conduct 5.12 Journal articles and thesis writing 5.13 Plagiarism	

J) **Suggested Laboratory Experiences:** (Not Applicable)

K) **Suggested Research Based Problems**

Research is a unique combination of art and science. Research is presumed to be associated with unpredictable uncertainties and variable degrees of technological endeavour. Research methodology is a systematic approach to reducing the degree of uncertainties. It helps in shaping the research orientation of a researcher. In this module, students were introduced to various aspects of research methodology. The students have been exposed to effective methods of problem definition, literature survey, reading and analysing research papers, design of experiments, ethical issues, and academic standard issues.

i. This part of the task is structured to test the researcher's comprehension skills and ability to adapt quickly to the rudimentary phase of the research cycle. The list of tasks to be performed is as follows.

- Identification of "Specific Field of Research" of the researcher's interest.
- Through a literature search, two doctoral theses have to be chosen that are closely related to an identified specific field of research
- The Abstract and Chapters on the Introduction, Conclusions, and Future recommendations of the two theses have to be reviewed

ii. Based upon the above-referred review, a technical note should be developed highlighting the:

- Introduction to the Identified "Specific Field of Research"
- Assumptions of the individual thesis
- Techniques invoked along with its merits and constraints of the individual thesis
- Relative differences in the approaches and scope of the two theses
- Views on the feasibility of incorporating the recommended suggestions of individual thesis
- Appreciation of the individual thesis reviewed with emphasis on introduction, problem definition and suggested future work

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Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L) Suggested Term Work (TW):

a. Assignment(s):

Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Seminar Topics:

- The Role of Literature Review in Building Research Frameworks
- Digital Tools for Research Data Collection and Management
- AI and Machine Learning in Research Methodology

M) Suggested Specification Table for End Semester Theory Assessment (ETA): Questions may be designed based on the higher taxonomy level of cognitive domain.

COs	Relevant Unit Number and Title	Marks
CO1	Unit-1.0 Basic Concepts of Research	08
CO2	Unit-2.0 Literature Review	08
CO3	Unit-3.0 Research Problem Formulation	12
CO4	Unit-4.0 Critical and Analytical Thinking	12
CO5	Unit -5.0 Research Proposal	10
Total		**50**

N) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O) Major Equipment, Tools and Software for Laboratory and Research Work: (Not Applicable)

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P)   **Suggested Learning Resources:**

a)   Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	The Craft of Research	Booth W. C, Colomb and G.G Williams	Chicago University Press
2.	Research Methods	Willium M.K and Trochim. (2003)	2nd Edition, Biztantra Publications
3.	The Foundation of Research	Jonathan Grix. (2004)	Palgrave Study Guides
4.	The Post Graduate Research	Wisker Gina. (2001)	Palgrave
5.	The Unwritten Rules of Ph.D research	Rugg G. and Petre M. (2004)	Open University Press

b)   Online Educational Resources (OER):

1)   https://www.youtube.com/watch?v=TEqYnV6KWfY
2)   https://www.youtube.com/watch?v=hECPeKv5tPM
3)   https://www.youtube.com/watch?v=G3DUaQokOK8
4)   https://onlinecourses.nptel.ac.in/noc23_ge36/preview
5)   https://nptel.ac.in/courses/121106007
6)   https://www.youtube.com/watch?v=E2gGF1rburw
7)   https://www.youtube.com/watch?v=E2gGF1rburw&list=PLyqSpQzTE6M8F_P8lgjvmqiDEoFGLzG4h
8)   https://www.youtube.com/watch?v=NNPiJ20JcFI&list=PLyqSpQzTE6M8F_P8lgjvmqiDEoFGLzG4h&index=8

Q)   **Course Curriculum Developer**

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A)	**Course Title:** Curriculum & Assessment
B)	**Course Code:** PC02
C)	**Pre- requisite (s):**

D)   **Rationale:** National Education Policy (NEP) 2020 envisions many innovations and reforms in the higher education. Major reforms mentioned are overhauling of curriculum, assessment and pedagogy. One of the major reforms is outcome-based curriculum design and development in the context of NEP:2020. Accordingly, all universities and institutions have started transforming the curriculum of higher education programmes to align with national policy directives and stakeholder's need in the changed context and era of industry 4.0 and skills demands. Many challenges and issues are envisaged in curriculum design & development, implementation, pedagogy and assessment in the context of NEP 2020.

The course curriculum on curriculum and assessment aims to deliberate on capability and capacity building of learners, policy makers, teachers etc. trainers on different reforms in curriculum design & development, pedagogy and assessment.

E)   **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
PC02.CO1	Develop awareness about the key concepts of outcome-based education and curriculum in the context of higher education.
PC02.CO2	Design innovative programme structure with scheme of studies and assessment as per the curriculum and assessment reforms envisaged in NEP 2020.
PC02.CO3	Implement the curriculum effectively to ensure the achievement of stated learning outcomes.
PC02.CO4	Revise the existing programme curriculum based on curriculum evaluation.
PC02.CO5	Assess the learners' performance by using the appropriate tools of assessment, as per need.

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F)   Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)		
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/document**.**	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PC02.CO1	1	1	3
PC02.CO2	3	3	3
PC02.CO3	2	1	3
PC02.CO4	3	3	3
PC02.CO5	1	1	3

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
PC02	PC	Curriculum and Assessment	30	-	-	30	60	02	20	30	50	-	-	-	100

H)   Course Curriculum Detailing: For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

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I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Explain the concept of outcome-based education **TSO 1b.** Differentiate between outcome-based curriculum and conventional curriculum. **TSO 1c.** Identify the curriculum reforms envisaged in NEP 2020 **TSO 1d.** Distinguish between curriculum and syllabus **TSO 1e.** Identify the key stakeholders of curriculum document	**Unit-1.0 Outcome Based Education and Curriculum** 1.1 Outcome Based Education (OBE) and curriculum. 1.2 Curriculum reforms in the context of NEP 2020- multidisciplinary and holistic curriculum. 1.3 Curriculum &syllabus- purposes and scope 1.4 Stakeholders of curriculum document, 1.5 Characteristics of good Curriculum document. 1.6 Policy directives for outcome-based curriculum development-NBA, AICTE and UGC	**CO1**
TSO 2a. Use contemporary approaches for design and development of curriculum. **TSO 2b.** Identify the key stages in curriculum planning, design and development. **TSO 2c.** Conduct need assessment from stakeholders (students, teachers, industry and alumni). **TSO 2d.** Use the need assessment results to arrive at curriculum design decisions. **TSO 2e.** Develop programme structure with scheme of studies and assessment for multidisciplinary programme. **TSO 2f.** Integrate the key curriculum and assessment reforms outlined in NEP 2020. **TSO 2g.** Describe the key components of outcome-based curriculum document. **TSO 2h.** Identify the unique features of multidisciplinary outcome-based curriculum	**Unit-2.0 Outcome Based Curriculum Design & Development** 2.1 Approaches of Curriculum Development: Tyler and Taba Model. 2.2 Stages of curriculum development-: Curriculum planning & design 2.3 Need assessment for curriculum design and development from different stakeholders. Design of tools for need assessment. 2.4 NEP 2020 curriculum and assessment reforms. 2.5 Innovative and flexible Programme Structure Development– Scheme of studies and scheme of assessment. 2.6 Flexible curriculum – Integration of emerging areas/technology in programme structure development. 2.7 Unique features of multidisciplinary outcome-based curriculum. 2.8 Elements/ Components of whole programme curriculum document. 2.9 Elements/Components of course curriculum document. 2.10 Domains of learning and course outcomes. Formulating course outcomes.	**CO2**
TSO 3a. Identify the roles of different stakeholders in effective curriculum implementation.	**Unit-3.0 Curriculum Implementations & Evaluation**	**CO3, CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 3b. Evolve strategies for effective curriculum implementation. *TSO 3c.* Solve issues and challenges faced during effective implementation of curriculum. *TSO 3d.* Analyze critical factors that influence the success or failure of curriculum implementation. *TSO 3e.* Apply the CIPP model to review and evaluate curriculum. *TSO 3f.* Revise the curriculum of programme and courses. *TSO 3g.* Develop e-contents for specific topic/sub topic as per outcomes stated.	3.1 Effective Curriculum Implementation: Issues and Challenges. 3.2 Innovative pedagogical methods /strategies for effective curriculum implementation, use of ICT for teaching learning. 3.3 Role of different stakeholders in effective curriculum implementation. 3.4 Factors influencing curriculum implementations, institutional support, teacher's competence, and student's engagement, entry level knowledge, skills and attitude etc. 3.5 CIPP model of curriculum evaluation. 3.6 Curriculum evaluation –strategies for effective implementation of curriculum. 3.7 Develop action plan for review and revision of existing programme and courses curriculum, based on evaluation results and emerging trends in education world of work 3.8 Role of teachers in effective curriculum implementation & evaluation considering the four pillars of NEP 2020- Access, Equity, Quality and Accountability. 3.9 Frameworks for Learning/Instructional material development: ADDIE and ASSURE 3.10 Leaning /Instructional materials development (e-contents).	
TSO 4a. Identify the purposes of outcome-based assessment *TSO 4b.* Differentiate between assessment, measurement and evaluation. *TSO 4c.* Apply appropriate assessment tools to assess the course outcomes across different learning domains. *TSO 4d.* Design rubrics for assessing student's performance during multiple tasks. *TSO 4e.* Design specification table *TSO 4f.* Design different types of questions	**Unit-4.0 Learners' Assessment** 4.1 Assessment, Measurement and Evaluation. 4.2 Characteristics of assessment – Validity, Reliability, Objectivity and Practicability. 4.3 Basic concepts of outcome-based assessment: Assessment for learning, Assessment of learning, Assessment as learning, Assessment before learning, process and product assessment. Issues and challenges in assessment. 4.4 Criterion Reference Testing (CRT) and Norms Reference Testing (NRT). 4.5 Direct and indirect tools of assessment 4.6 Assessment of outcomes in Cognitive, Affective, and Psychomotor domain.	CO5

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Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	4.7 Rubrics based assessment: Design of Rubric for assessing Project work, Industrial Training, Seminar, Laboratory experiences, workshop experiences, etc. 4.8 Design of Specification table for assessment in cognitive and psychomotor domain. 4.9 Different types of questions-Multiple choice questions, short answer question, structured essay questions, etc. 4.10 Bloom's taxonomy and design of question paper.	

J)   Suggested Laboratory Experiences: (Not Applicable)

K)   Suggested Research Based Problems

    i.   Carry out the need assessment from different stakeholders and analyze the same to draw the curricular decisions for development of multidisciplinary flexible programme structure of Diploma/Degree programmes.

    ii. Identify the norms of project, internship and industrial training in AICTE and UGC guidelines for integration in curriculum design and development.

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L)   Suggested Term Work (TW):

a.   Assignment(s):

Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

- Prepare a basket of emerging technology courses, open elective courses, emerging stream specific courses, NEP courses, NEP courses as per need of specific programme for integration in programme structure across the programme.
- Develop most valid and reliable T-L and assessment tool for effective implementation and assessment of capstone/major project work.
- Features of NCrF for Curriculum Design and Development
- Unique features of NHEQF
- Innovative programme structure development by integration of academic, experiential learning and vocational component.

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b. Seminar Topics:

- Emerging and futuristic models and approaches of curriculum design and development
- NEP envisions and curriculum ad Assessment Reforms.
- Categorize the cluster of programme courses, as pre the different category of courses.
- Map the appropriate courses as per the different category of courses.

M) **Suggested Specification Table for End Semester Theory Assessment (ETA):** Questions may be designed based on the higher taxonomy level of cognitive domain.

COs	Relevant Unit Number and Title	Marks
CO1	Unit 1.0 Outcome Based Education and Curriculum	04
CO2	Unit 2.0 Outcome Based Curriculum Design & Development	10
CO3, CO4	Unit 3.0 Curriculum Implementations & Evaluation	08
CO5	Unit 4.0 Learners' Assessment	08
Total		**30**

N) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O) **Major Equipment, Tools and Software for Laboratory and Research Work:** (Not Applicable)

P) **Suggested Learning Resources:**
   a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Curriculum: Foundations, Principles & Theories	Ornstein, A.C	Pearson; 7th edition (6 January 2016), ISBN-10: 0134060350, ISBN-13: 978-0134060354
2.	Concept-based Curriculum and Instruction	Erickson, H.L.	Publisher: Corwin; 1st edition (1 August 2006), ISBN-10: 141291700X, ISBN-13: 978-1412917001

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S. No.	Titles	Author(s)	Publisher and Edition with ISBN
3.	Principles of Curriculum Construction	Balasara, M	Kanishka; First Edition (1 January 2017), ISBN-10: 8173916217 ISBN-13: 978-8173916212
4.	Advanced Curriculum Construction	Prasad, J. &Kaushik, V. K	Publisher: Kanishka Prakshan; First Edition (1 January 2009), ISBN-10: 8173916772, ISBN-13: 978-8173916779
5.	'Curriculum theory and practice'	Smith, M. K. (1996, 2000)	www.infed.org/biblio/b-curric.htm.
6.	Outcome-Based Curriculum in Engineering Education	Shashi Kant Gupta, Joshua Earnest	PHI Learning; 1st edition (1 November 2021)
7.	Outcome Based Education: A Practical Guide for Higher Education Teachers	Deepesh Divaakaran	Notion Press (30 June 2023); Notion Press Media Pvt Ltd, ISBN-13: 979-8890268945
8.	Designing and Implementing the Outcome-Based Education Framework: Theory and Practice	P P Noushad	Springer (14 December 2024), ISBN-10: 9819604397, ISBN-13: 978-9819604395
9.	Assessment for Learning	Paul Black, Chris Harrison, Clara Lee, Bethan Marshall, Dylan Wiliam	Open University Press (16 September 2003), ISBN-10: 0335212972 ISBN-13: 978-0335212972
10.	ASSESSMENT FOR LEARNING [Paperback]	DR.A.JAHITHA BEGUM, DR.G.LOKANA DHA REDDY	RAKHI PRAKASHAN; First Edition (1 January 2015), ISBN-10: 9385195247 ISBN-13: 978-9385195242
11.	Curriculum Implementation and Instruction	Abayomi Oluwatelure Temitayo	LAP Lambert Academic Publishing (2 March 2011), ISBN-10: 9783843362740, ISBN-13: 978-3843362740

b) Online Educational Resources (OER):

1)   https://onlinecourses.swayam2.ac.in/ntr24_ed10/preview
2)   https://nptel.ac.in/courses/127105017
3)   https://onlinecourses.swayam2.ac.in/ntr20_ed03/preview
4)   https://onlinecourses.swayam2.ac.in/ntr22_ed16/preview
5)   https://onlinecourses.swayam2.ac.in/ntr19_ed16/preview
6)   https://www.youtube.com/watch?v=zhvzu8WkQs4
7)   http://youtube.com/watch?v=vRKRQi2QnAQ&t=5s

Q)   Course Curriculum Developer

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A)	**Course Title:** Indian Knowledge System (IKS)	
B)	**Course Code:** NEP06	
C)	**Pre- requisite (s):**	

D) **Rationale:** This course will survey the basic structure and operative dimensions of Indian knowledge system. With the new education policy-NEP 2020 focusing on Indian Knowledge Systems (IKS) and Traditions of India. This course introduces the learners to the rich and varied knowledge traditions of India from antiquity to the present. This also helps the learner to know and understand their own systems and traditions which are imperative for any real development and progress. Also, it helps the learner to think independently and originally adopting Indian frameworks and models for solving the problems related to world of work where the student is supposed to perform.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
NEP06.CO1	Identify the rich heritage and legacy residing in our Indian Knowledge systems.
NEP06.CO2	Correlate the technological & philosophical concepts of IKS with engineering domain specific problems and local problems for finding out possible solutions

F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes (COs)	Programme Outcomes (POs)				
	PO-1 Apply knowledge of management theories and practices to solve business problems.	**PO-2** Foster Analytical and critical thinking abilities for data-based decision-making.	**PO-3** Ability to develop Value based Leadership ability.	**PO-4** Ability to understand, analyze and communicate global, economic, legal, and ethical aspects of business.	**PO-5** Ability to lead themselves and others in the achievement of organizational goals, contributing effectively to a team environment.
NEP06.CO1	1	-	1	-	-
NEP06.CO2	1	1	1	-	-

Legend: High (3), Medium (2), Low (1) and No mapping (-)

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G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		Total Marks (TA+TWA+LA)
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
NEP06	NEP	Indian Knowledge System (IKS)	15	-	-	15	30	01	25	-	25	-	-	-	50

H)   Course Curriculum Detailing:
For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Explain the architecture of the Ancient Indian Knowledge Systems. *TSO 1b.* List the salient features of IKS. *TSO 1c.* Comprehend the given IKS model. *TSO 1d.* Identify the role and relevance of the given IKS model in contemporary society.	**Unit-1.0 Introduction to Indian Knowledge Systems** 1.1 Overview of IKS 1.2 Organization of IKS – चतुर्दश-विद्यास्थानं 1.3 Conception and Constitution of Knowledge in Indian Tradition 1.4 The Oral Tradition 1.5 Models and Strategies of IKS	**CO1**
TSO 2a. Enlist the importance of Veda, Vedanga, Visaya, Siksaka. *TSO 2b.* Describe the given IKS domain. *TSO 2c.* Identify elements of mentioned IKS domains that are relevant to Technical Education System. *TSO 2d.* Correlate the elements of mentioned IKS domains with given engineering domain.	**Unit-2.0 Overview of IKS domains and relevance in current Technical Education System.** 2.1 The Vedas as the basis of IKS 2.2 Overview of all the six Vedāṅgas 2.3 Relevance of following IKS domains in present Technical Education System: • Arthashastra (Indian economics and political systems) • Ganita and Jyamiti (Indian Mathematics, Astronomy and Geometry • Rasayana (Indian Chemical Sciences)	**CO1, CO2**

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Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	• Ayurveda (Indian Biological Sciences / Diet & Nutrition) • Jyotish Vidya (Observational astronomy and calendar systems) • Prakriti Vidya (Indian system of Terrestrial/ Material Sciences/ Ecology and Atmospheric Sciences) • Vastu Vidya (Indian system of Aesthetics-Iconography and built-environment /Architecture) • Nyaya Shastra (Indian systems of Social Ethics, Logic and Law) • Shilpa and Natya Shastra (Indian Classical Arts: Performing and Fine Arts) • Sankhya and Yoga Darshna (Indian psychology, Yoga and consciousness studies) • Vrikshayurveda (Plant Science / Sustainable agriculture/food preservation methods)	

J)   Suggested Laboratory Experiences: (Not Applicable)

K)   Suggested Research Based Problems:

a. Relevance of Ayurveda in Modern Healthcare

- Problem: How can Ayurvedic principles be integrated into modern medical practices to provide holistic healthcare solutions?
- Focus: Researching the efficacy of Ayurvedic treatments in chronic diseases, lifestyle disorders, and preventive healthcare, and exploring ways to bridge Ayurveda with modern healthcare systems.

b. Vedic Astronomy and Modern Astrophysics: A Comparative Study

- Problem: What are the similarities and differences between ancient Vedic astronomy and modern astrophysical theories?
- Focus: Exploring ancient Indian astronomical texts like the *Surya Siddhanta* and their insights into planetary motions, eclipses, and cosmology, and comparing these with contemporary astronomical models.

c. Yoga and Mental Health: A Scientific Perspective

- Problem: How can the practice of Yoga and its underlying philosophical principles contribute to mental health therapies in modern psychology?
- Focus: Exploring the psychological benefits of yogic practices like meditation, pranayama, and asanas, and scientifically evaluating their impact on anxiety, depression, and stress management.

   d. **The Role of Ancient Indian Agriculture in Sustainable Farming Practices**

   - Problem: How can ancient Indian agricultural practices, such as organic farming and crop rotation, be applied to address contemporary challenges in sustainable agriculture?
   - Focus: Investigating ancient texts like the *Krishi-Parashara* and traditional knowledge in water management, soil conservation, and sustainable farming, and adapting these to modern agricultural practices.

   e. **Vedic Mathematics and Its Role in Contemporary Education**

   - Problem: How can Vedic Mathematics techniques be integrated into modern education systems to enhance students' computational skills and logical reasoning?
   - Focus: Researching the techniques of Vedic Mathematics and exploring their effectiveness in improving mathematical literacy and problem-solving abilities among students.

   f. **Natyashastra and Its Influence on Modern Theatre and Performing Arts**

   - Problem: What are the enduring influences of *Natyashastra*, the ancient Indian treatise on performing arts, on modern theatre, dance, and cinema?
   - Focus: Analyzing the principles of *Natyashastra* in terms of aesthetics, drama, and performance, and exploring its relevance and application in contemporary performing arts.

   g. **Traditional Indian Water Management Systems: Lessons for the Future**

   - Problem: How can traditional water management systems, like step wells and rainwater harvesting structures from ancient India, be revived to solve modern water scarcity issues?
   - Focus: Investigating ancient Indian water management practices and their sustainability, and exploring their application in current water conservation efforts and urban planning.

   h. **Ancient Indian Contributions to Astronomy and Navigation**

   - Problem: What were the contributions of ancient Indian scholars to the field of navigation and astronomy, and how can this knowledge be applied in modern scientific advancements?
   - Focus: Exploring the contributions of ancient Indian navigators and astronomers in calculating planetary positions, timekeeping, and navigation, and their influence on global knowledge systems.

   i. **Military Science in Ancient India and Its Lessons for Modern Defense Strategies**

   - Problem: What can modern military strategists learn from ancient Indian military texts like *Niyuddha Kala* and *Arthashastra*?
   - Focus: Studying ancient Indian warfare techniques, battle strategies, and defense technologies, and their relevance in contemporary military science and national defense planning.

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

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L)   Suggested Term Work (TW):

a.   Assignment(s):

Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

i.   Comparative Study of Ayurveda and Modern Medicine
- Objective: Compare the principles of Ayurveda with modern medicine in the treatment of common diseases.
- Assignment: Select a particular health issue (e.g., diabetes, hypertension) and compare Ayurvedic approaches with modern medical treatments. Discuss the strengths and limitations of both systems.

ii.   Contributions of Ancient Indian Mathematicians
- Objective: Explore the contributions of ancient Indian mathematicians like Aryabhata, Bhaskara, and Brahmagupta.
- Assignment: Write a research paper on a specific mathematical concept (e.g., zero, algebra) developed by ancient Indian scholars and its relevance in modern mathematics.

iii.   Analysis of Vedic Astronomy and Its Accuracy
- Objective: Understand how ancient Indian astronomers calculated celestial movements.
- Assignment: Analyze a Vedic astronomical text, such as the Surya Siddhanta, and discuss its accuracy in predicting celestial phenomena like solar or lunar eclipses.

iv.   Traditional Water Management Systems in India
- Objective: Investigate ancient Indian water management techniques and their sustainability.
- Assignment: Select a traditional water conservation structure (e.g., step wells, tanks) and analyze its design, efficiency, and potential application in addressing modern water scarcity.

v.   Impact of Yoga on Mental and Physical Health
- Objective: Explore the benefits of Yoga on mental and physical well-being.
- Assignment: Research the scientific basis of a particular Yoga practice (e.g., pranayama, meditation) and its impact on health, using both ancient texts and modern scientific studies.

vi.   Sustainable Agriculture Practices in Ancient India
- Objective: Investigate traditional agricultural methods in ancient India and their relevance today.
- Assignment: Study a specific ancient agricultural practice (e.g., organic farming, crop rotation) and evaluate how it can address current challenges like soil degradation or climate change.

vii.   Chandashastra (Prosody) and Its Application in Modern Poetry
- Objective: Understand the significance of Chandashastra in shaping poetic meter and structure.
- Assignment: Select a Vedic meter (chandas) from Chandashastra and compare its structure with modern poetic forms, analyzing similarities and differences.

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    viii. **Study of Natyashastra and Its Influence on Modern Performing Arts**
- Objective: Analyze the influence of Natyashastra on modern performing arts.
- Assignment: Research a section of Natyashastra related to drama or dance, and explain how its principles are applied or can be applied in modern theatre or cinema.

    ix. Indian Metallurgy: Ancient Innovations and Modern Applications
- Objective: Understand ancient Indian metallurgical practices and their significance.
- Assignment: Study an ancient Indian metallurgical achievement, such as the rust-resistant Iron Pillar of Delhi, and analyze the scientific techniques used. Compare this with modern metallurgical practices.

    b. **Seminar Topics:**

- "Ayurveda: The Ancient Science of Healing in Modern Healthcare"
- "Mathematical Brilliance of Ancient India: Contributions of Aryabhata and Beyond"
- "Vedic Astronomy: Insights from the Cosmos in Ancient India"
- "Sanskrit and Artificial Intelligence: The Linguistic Bridge to Future Technologies"
- "Iron Pillar of Delhi: The Science Behind Ancient Indian Metallurgy"
- "Yoga for Mental Health: A Scientific Exploration of Ancient Practices"
- "Ancient Indian Water Management Systems: Lessons for Sustainable Development"
- "Ethics in the Mahabharata: Leadership Lessons for the Modern World"
- "Vedic Mathematics: Speed and Simplicity in Problem Solving"
- "Natyashastra: The Ancient Indian Treatise on Performing Arts"
- "Logic and Disputation in Ancient India: The Role of Anviksiki"
- "Traditional Indian Agriculture: Pathways to Sustainable Farming"
- "The Science of Consciousness: Vedantic Insights and Modern Neuroscience"
- "Ancient Indian Contributions to Navigation and Maritime Science"
- "Chandashastra: The Science of Prosody in Sanskrit Poetry"
- "Military Strategies of Ancient India: Lessons from the Arthashastra"
- "Environmental Conservation in Ancient Indian Philosophy: Vedic Insights"
- "Traditional Indian Medicine: Exploring the Efficacy of Siddha and Unani Systems"
- "Agricultural Economics in Ancient India: Insights from Arthashastra and Krishi-Parashara"
- "Traditional Indian Knowledge in Climate Change Adaptation"

M) **Suggested Specification Table for End Semester Theory Assessment (ETA):** (Not Applicable)

N) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

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O)   Major Equipment, Tools and Software for Laboratory and Research Work: (Not Applicable)

P)   Suggested Learning Resources:

   a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Introduction to Indian Knowledge System: Concepts and Applications	Archak, K.B. (2012).	Kaveri Books, New Delhi ISBN-13:978-9391818203
2.	Introduction To Indian Knowledge System: Concepts and Applications	Mahadevan, B. Bhat, Vinayak Rajat Nagendra Pavana R.N.	PHI, ISBN: 9789391818203
3.	Glimpse into Kautilya's Arthashastra	Ramachandrudu P. (2010)	Sanskrit Academy, Hyderabad ISBN:9788380171074
4.	"Introduction" in Studies in Epics and Purāṇas, (Eds.)	KM Munshi and N Chandrashekara Aiyer	Bhartiya Vidya Bhavan

   b) Online Educational Resources (OER):

   1)   http://bhavana.org.in
   2)   www.academia.edu/23254393/Science_in_Ancient_India_-_an_educational_module
   3)   www.academia.edu/23305766/Technology_in_Ancient_India_-_Michel_Danino
   4)   www.hamsi.org.nz/http://insaindia.res.in/journals/ijhs.php
   5)   www.niscair.res.in/sciencecommunication/ResearchJournals/rejour/ijtk/ijtk0.asp
   6)   www-history.mcs.st-andrews.ac.uk/Indexes/Indians.html
   7)   Swami Harshananda. "A bird's eye view of vedas". R K Math. Bangalore.,http:// rkmathbangalore. org/Books/ABirdsEyeViewOfTheVedas.pdf.
   8)   Sanskrit Prosody, https://en.wikipedia.org/wiki/Sanskrit_prosody.
   9)   Vartak, P.V. (1995). "Veda and Jyotish," Part II, Chapter 2, in Issues in Veda and Astrology, H Pandya (Ed.), pp 65 – 73.

Q)   Course Curriculum Developer

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Course Curriculum Detailing- Online Spell -2

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A)	**Course Title:** MOOC Creation
B)	**Course Code:** PC03
C)	**Pre- requisite (s):**

D)   Rationale: The exponential growth of online education, accelerated by global digital transformation, has created an unprecedented demand for high-quality Massive Open Online Courses (MOOCs). Engineering professionals are increasingly required to share their expertise through digital platforms, conduct training programs, and contribute to knowledge dissemination on a global scale. This course addresses the critical need to develop competencies in educational technology design, content creation, and online pedagogy. Students will gain practical experience in conceptualizing, designing, developing, and deploying MOOCs that can reach thousands of learners worldwide. The course integrates engineering problem-solving approaches with educational design principles, enabling graduates to create impactful learning experiences in their respective engineering disciplines. The course aligns with Industry 4.0 requirements, where professionals must not only possess technical expertise but also the ability to transfer knowledge effectively through digital mediums. This skill is particularly valuable for careers in academia, corporate training, consulting, and entrepreneurship in the education technology sector.

E)   Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
PC03.CO1	Develop a comprehensive MOOC course structure using instructional design principles.
PC03.CO2	Prepare sample e-content lessons.
PC03.CO3	Produce sample digital media content.
PC03.CO4	Upload the MOOC course structure and its components as per the given guidelines on the LMS.

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F)   Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)		
	PO-1 Independently carry out research/ investigation, and development work to solve practical problems.	**PO-2** Write and present a substantial technical report/ document**.**	**PO-3** Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program
PC03.CO1	3	3	3
PC03.CO2	2	2	3
PC03.CO3	2	2	3
PC03.CO4	-	2	2

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
PC03	PC	MOOC Creation	30	-	-	30	60	02	20	30	50	-	-	-	100

H)   Course Curriculum Detailing: For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

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I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Explain the evolution, characteristics, and types of MOOCs. *TSO 1b.* Interpret learner demographics, motivations, and challenges in MOOC environments. *TSO 1c.* Apply instructional design framework and models for MOOC development. *TSO 1d.* Formulate MOOC outcomes. *TSO 1e.* Design the MOOC course structure.	**Unit-1.0 Foundation of MOOC Design** 1.1 History and evolution of MOOCs. 1.2 MOOCs types and their characteristics. 1.3 Role of learning theories in MOOC design. 1.4 Learner psychology in massive open environments. 1.5 Instructional design frameworks and Models – ADDIE, SAM, Advance Organizer. 1.6 MOOC Components. 1.7 Formulating MOOC outcomes. 1.8 Content structuring and organisation	**CO1**
TSO 2a. Explain the philosophy of self-learning material development. *TSO 2b.* Integrate principles of microlearning and media design for content creation. *TSO 2c.* Integrate elements of Dale's Cone of Experience and principles of micro-learning in the development of lessons. *TSO 2d.* Prepare a bank of OER to be integrated into the MOOC. *TSO 2e.* Prepare a lesson/s along with assessment questions and discussion forum statement as per the given guideline	**Unit-2.0 E-Content Lesson Development** 2.1 Philosophy for the development of self-learning material. 2.2 Principles of microlearning and Media design. 2.3 Dale's cone of experience. 2.4 Intellectual Property rights, OER and Creative Commons licenses. 2.5 Designing MCQ and Discussion forum. 2.6 Rubrics for ''Prepare a sample prototype E Content'' 2.7 Sample format/s for the development of lessons mentioned in the course structure.	**CO2**
TSO 3a. Design graphics, animation, presentation and interactive content using media design principles. *TSO 3b.* Create a sample podcast for MOOC. *TSO 3c.* Write a sample video script for the selected MOOC lesson. *TSO 3d.* Write a shooting script. *TSO 3e.* Plan for video production. *TSO 3f.* Present to camera in studio. *TSO 3g.* Edit the video and sound file for finalisation of the sample video.	**Unit-3.0 Digital Media Production** 3.1 Video production pipeline – Video production vocabulary. 3.2 Multi-camera studio production. 3.3 Podcast creation. 3.4 Video script development. 3.5 Graphics design and animation. 3.6 Shooting script development. 3.7 Interactive content creation tools. 3.8 Audio and video editing.	**CO3**
TSO 4a. Describe features of the SWAYAM MOOCs. *TSO 4b.* Design the course structure on ePrashikshan. *TSO 4c.* Verify that all MOOC components developed adhere to LMS guidelines.	**Unit-4.0 MOOC Course Configuration on LMS and its Guidelines** 4.1 SWAYAM Guidelines for MOOC development. 4.2 Overview of SWAYAM MOOC structure.	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 4d. Upload MOOC components on ePrashikshan. *TSO 4e.* Test the MOOC course using the pre-launch checklist.	4.3 LMS (ePrashikshan) and its features for MOOC 4.4 LMS-specific guidelines for video duration, file formats, accessibility standards, copyright policies, and assessment requirements 4.5 LMS structure design aspects aligned to course structure (course builder) 4.6 Steps for uploading the MOOC component on LMS 4.7 Steps for publishing MOOC content 4.8 Pre-launch Checklist for LMS - Test all links and embedded media, Review course flow from a learner's perspective, Check quiz functionality and grading settings, test for cross-device and browser compatibility 4.9 Pilot and beta testing	

J)   Suggested Laboratory Experiences: (Not Applicable)

K)   Suggested Research Based Problems (10 marks- part of term work)

   i.   Prepare a review paper based on the latest research on the theme related to MOOC design/ delivery/ Assessment of Effectiveness of content/ Effectiveness of activities.

   ii.   Compare the MOOC course structure of various MOOCs offered on different platforms and present.

   iii.   Compare different video formats used in various MOOCs offered on different platforms and present.

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L)   Suggested Term Work (TW):

   a.   Assignment(s): A portfolio consisting of the following- (6 Marks each)

- Design of Course Builder and Flyer
- Create a bank of OERs related to the MOOC topic.
- Design of Sample e-content lesson along with SAQs
- Design of Presentation and video recording
- Design of Assessment MCQs for the sample content produced

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b. **Seminar presentation: Presentation of the MOOC developed in the seminar (10 Marks)**

M) **Suggested Specification Table for End Semester Theory Assessment (ETA):** Questions may be designed based on the higher taxonomy level of cognitive domain.

COs	Relevant Unit Number and Title	Marks
CO1	Unit 1.0 Foundation of MOOC Design	03
CO2	Unit 2.0 E-Content Lesson Development	06
CO3	Unit 3.0 Digital Media Production	15
CO4	Unit 4.0 MOOC Course Configuration on LMS and its Guidelines	06
Total		**30**

N) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O) **Major Equipment, Tools and Software for Laboratory and Research Work:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experience / Practical Number
1.	Multi-camera studio setup with teleprompter, chroma key set, storage system, lights and audio equipment	Three video cameras set up, HD/ 4K, with Camera Control Unit, Tripod, HD/ 4K recorder, Recording media, Studio lights, different types of microphones and storage system.	All
2.	DSLR Camera setup	Digital HD/ 4K still plus video camera with flash and recording media.	All
3.	Hi-end computer systems	HP Workstation with Intel Core i9 13900 Processor, 32 GB, 1 TB HDD for video editing and graphics preparation.	All
4.	Graphics designing software	Adobe Creative Suite CS 4, Adobe Creative Cloud 2025, Canva	All
5.	Video editing software	Adobe Creative Suite CS 4, Adobe Creative Cloud 2025	All
6.	Sound editing software	Adobe Creative Suite CS 4, Adobe Creative Cloud 2025	All

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P)   Suggested Learning Resources:

   a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	The Cambridge Handbook of Multimedia Learning	Edited by Richard E. Mayer, University of California, Santa Barbara, and Logan Fiorella, University of Georgia	Cambridge University Press, 3rd Edition, Online ISBN: 9781108894333 https://doi.org/10.1017/9781108894333

   b) Online Educational Resources (OER):

1)   https://storage.googleapis.com/swayam2_central/swayam1/wqimgtest_f8b95943-b963-49b9-85ed-416f2e15d1b4.pdf

2)   https://storage.googleapis.com/swayam2_central/swayam1/UGC_Gazette-Credit_Framework_for_Online_Courses_through_SWAYAM.pdf

3)   https://storage.googleapis.com/swayam2_central/swayam1/wqimgtest_9da02ba8-bdd8-409c-afdb-645e6dbc544f.pdf

4)   https://swayam.gov.in

5)   https://pmevidya.education.gov.in/swayam-portal.html

6)   https://swayam.inflibnet.ac.in

7)   https://spoken-tutorial.org

8)   https://epgp.inflibnet.ac.in

9)   https://search.creativecommons.org

Q)   Course Curriculum Development Team

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A)	**Course Title:** Learner Centric Instructional Methods
B)	**Course Code:** PC04
C)	**Pre- requisite (s):**

D)   Rationale: For planning and implementing a teaching learning session, number of instructional choices are involved, of which one of the vital decisions is regarding the instructional methods to be employed. Learner-centric approaches have proven more effective than traditional teacher-centric methods because they actively engage students in the learning process, empowering them to achieve intended outcomes through meaningful participation. Building on this foundation, Artificial Intelligence has emerged as a transformative force in contemporary education, creating new possibilities for personalized learning, adaptive instruction, and intelligent tutoring systems. This course introduces learners to a comprehensive range of learner centric instructional methods, including these AI-enhanced pedagogical approaches, enabling them to strategically match content with effective delivery strategies. Such alignment becomes particularly valuable for those considering teaching careers in educational institution. Furthermore, the course benefits all learners by equipping them with methods they can immediately apply to enhance their own learning experiences.

E)   Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
PC04.CO1	Apply the principles of learning to enhance the effectiveness of instructional process to achieve intended learning outcomes in different domains.
PC04.CO2	Plan to use appropriate instructional method effectively for developing learning outcomes.
PC04.CO3	Interpret the suitability of small group methods to enhance teaching learning effectiveness ensuring learner participation.
PC04.CO4	Devise effective strategy using appropriate learner centred instructional methods and AI tools for a given content.

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F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)		
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/document.	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PC04.CO1	-	2	3
PC04.CO2	2	2	2
PC04.CO3	2	2	2
PC04.CO4	2	2	2

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
PC04	PC	Learner Centric Instructional Methods	30	-	-	30	60	02	30	50	20	-	-	-	100

H) Course Curriculum Detailing:
For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

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I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Justify the need for a variety of instructional methods to attain learning outcomes. *TSO 1b.* Formulate learning outcomes at different taxonomic levels of Cognitive, Affective and Psychomotor domains. *TSO 1c.* Enhance effectiveness of session integrating principles of learning and events of instruction. *TSO 1d.* Classify different types of instructional methods and strategies. *TSO 1e.* Identify potential issues and concerns associated with Teacher centric method *TSO 1f.* Develop an instructional session plan.	**Unit -1.0 Learning Principles and Instructional Methods** 1.1 Learning in different Domains, Learning Outcomes in different domains 1.2 Principles of Learning and Events of Instruction 1.3 Need for Variety of Instructional Methods 1.4 Classification of Instructional Methods and Strategies: Learner Centric and Teacher Centric Methods 1.5 Instruction Session Planning and Implementation	**CO1**
TSO 2a. Use tutorial method effectively. *TSO 2b.* Employ assignment method to develop the pre-determined outcomes. *TSO 2c.* Plan to use laboratory and workshop as an effective instructional method for developing practical skills. *TSO 2d.* Interpret the different techniques of developing workshop related skills. *TSO 2e.* Use project work effectively in teaching-learning situations. *TSO 2f.* Describe how problem-based learning can build critical thinking and reasoning skills.	**Unit-2.0 Interactive and Action Oriented Instructional Methods** 2.1 Question-Answer Technique 2.2 Tutorial Method 2.3 Assignment Method 2.4 Laboratory Work 2.5 Workshop Method 2.6 Project work 2.7 Problem Based Learning	**CO2**
TSO 3a. Use seminar method effectively. *TSO 3b.* Employ case study and group discussion. *TSO 3c.* Explain the strategy to improve the effectiveness of classroom teaching-learning process using Buzz Group method.	**Unit-3.0 Small Group Instructional Methods** 3.1 Seminar Method 3.2 Case Study Method 3.3 Group Discussion 3.4 Buzz Group Session 3.5 Brain Storming Technique	**CO3**
TSO 4a. Describe the principles and advantages of individualized instruction. *TSO 4b.* Explain the need and abilities required for self-learning. *TSO 4c.* Justify the need for variety of ICT Based Techniques for enhancing learning. *TSO 4d.* Explain the way blended and flipped learning approaches can be applied in teaching learning process for improving students' learning. *TSO 4e.* Analyze how AI can enhance effectiveness of instructional sessions.	**Unit-4.0 Online Learning Methods** 4.1 Individualized learning 4.2 Self-Learning 4.3 ICT Based Techniques to enhance Learning (E-learning Platforms: MOOCs, LMS, Educational Apps and Tools, Online Collaboration Tools) 4.4 Applications of AI in Education, AI-powered virtual laboratories 4.5 AI-Powered Personalized Learning Systems: Intelligent Tutoring Systems, Adaptive	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 4f. Evaluate AI-powered personalized learning systems and their effectiveness.	Learning Platforms, AI Chatbots for Education 4.6 Blended and Flipped Learning Approach	

J) Suggested Laboratory Experiences: (Not Applicable)

K) Suggested Research Based Problems

    a. Perform a literature review on the features and effectiveness of instructional methods that have evolved during recent years.

    b. Find out the common barriers perceived in an educational institution in adopting learner-centric instructional strategies.

    c. Evaluate the learner satisfaction and motivation, comparing conventional lecture methods and learner-centric approaches

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L) Suggested Term Work (TW):

    a. Assignment(s):

Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

- Formulate learning outcomes at different taxonomic levels of Cognitive, Affective and Psychomotor domains for an identified course.
- Develop a simple case with brief for an identified course.
- Identify the practical outcomes to be developed through lab experiences for an identified course.
- Identify topics in your area where project method (both minor and major) can be used.
- Prepare instructional session plan for at least three lessons from a selected course.
- Implement the instructional session plan developed in Assignment a4 and upload the recorded video of simulated experience.

    b. Seminar Topics:

- Inquiry-Based Learning: Fostering Critical Thinking and Student Investigation
- Theories of Learning
- Learning Styles
- Digital Tools for Student-Centered Education
- Differentiated Instruction process
- Student Self-Assessment
- Gamification and Game-Based Learning
- Experiential Learning: Learning through Direct Experience and Reflection

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M) Suggested Specification Table for End Semester Theory Assessment (ETA): Questions may be designed based on the higher taxonomy level of cognitive domain.

COs	Relevant Unit Number and Title	Marks
CO1	Unit-1.0 Learning Principles and Instructional Methods	14
CO2	Unit-2.0 Interactive and Action Oriented Instructional Methods	14
CO3	Unit-3.0 Small Group Instructional Methods	12
CO4	Unit-4.0 Online Learning Methods	10
Total		**50**

N) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O) Major Equipment, Tools and Software for Laboratory and Research Work: (Not Applicable)

P) Suggested Learning Resources:

    a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Teaching Strategies: A Guide to Effective Instruction	Orlich, Donald C., Harder, Robert J., Trevisan, Michael S., Brown, Abbie H., and Miller, Darcy E.	Cengage Learning, Eleventh Edition, 2017, ISBN: 978-1305960787
2.	Methods and Techniques of Teaching	Kochhar, S. K.	Sterling Publishers, 2018 ISBN: 978-8120700710
3.	A Taxonomy for Learning, Teaching and Assessing - A revision of Bloom's taxonomy of Educational Objectives	Anderson, L. W., and Krathwohl, D. R.	Pearson Education, First Edition, 2001 ISBN: 978-0801319037
4.	Effective Teaching Methods: Research-Based Practice	Borich, Gary D.	Pearson, Tenth Edition, 2021, ISBN: 978-0136794271
5.	Devise Teaching Strategies and Select Teaching Methods: Module No.2	Banthiya N. K., Earnest Joshua, Mathew Susan S. (Ed.)	TTTI Bhopal, 1999

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S. No.	Titles	Author(s)	Publisher and Edition with ISBN
6.	Teaching Strategies: A Guide to Effective Instruction	Donald C. Orlich, Robert J. Harder, Michael S. Trevisan, Abbie H. Brown, Darcy E. Miller	Cengage Learning, 2016, Eleventh Edition, ISBN: 978-1305960787
7.	Advanced Teaching Methods for the Technology Classroom	Petrina, Stephen	IGI Global, 2010, ISBN: 978- 1599043371
8.	Theory and Practice of Case Method of Instruction	Bahttacharya, B.	Excel Books, 2015, ISBN: 9788174465588
9.	Artificial Intelligence in Education: Promises and Implications for Teaching and Learning	Holmes, Wayne, Bialik, Maya, and Fadel, Charles	Center for Curriculum Redesign, 2019, ISBN: 978-1794237111
10.	AI for Teaching and Learning: A Guide for Educators	Chen, Li, Dede, Chris	Harvard Education Press, 2021, ISBN: 978-1682536094

b) Online Educational Resources (OER):

1) http://nufosece.ru/fipofoq.pdf; "Teaching Strategies: A Guide to Better Instruction"
2) http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1413&context=asdpapers; Tools for learning: Technology and teaching strategies Michelle Eady and Lori Lockyer
3) https://onlinecourses.swayam2.ac.in/ntr24_ed52/preview; "Basic Instructional Methods"
4) https://onlinecourses.swayam2.ac.in/ntr24_ed49/preview; "Advanced Instructional Methods"
5) https://nittt.ac.in/modules/Module-4.pdf; "Module 4: Instructional Planning and Delivery"
6) http://unesdoc.unesco.org/images/0010/001095/109590eo.pdf; Delors, J. et al. 1996, Learning: The Treasure Within. Report to UNESCO of the International Commission on Education for the Twenty-First Century. Paris, UNESCO
7) https://www.edx.org/course/artificial-intelligence-in-education; "AI in Education: Fundamentals and Application
8) https://www.coursera.org/specializations/ai-for-teaching-and-learning; "AI for Teaching and Learning Specialization"
9) https://www.unesco.org/en/articles/artificial-intelligence-education-challenges-and-opportunities-sustainable-development; "UNESCO AI in Education Guidelines"
10) https://onlinecourses.swayam2.ac.in/ntr25_ed40/preview, "Integration of Artificial Intelligence in Educational Practices"

Q)   Course Curriculum Development Team

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A)	**Course Title:** Intellectual Property Rights (IPR)	
B)	**Course Code:** NEP07	
C)	Pre- requisite (s):	

D) **Rationale:** Intellectual Property Rights encourage continued creativity and artistic innovation, enriching cultural heritage and promoting diversity in the creative industries by safeguarding the rights of creators and artists under appropriate acts/laws. This course will enable the students to protect their inventions, creative work/assets/product under intellectual property Rights such as patents, copyrights, trademarks, Geographical Indications, Industrial designs, layout of Integrated Circuit design, trade secrets, Traditional knowledge, Plant varieties and Farmer's protection under various IPR laws and acts to succeed in their career and avoid unnecessary litigations.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following industry expected course outcomes by the learners.

Course Outcomes (COs)	Course Outcome Statements
NEP07.CO1	Realize the need and significance of Intellectual property (IP), Intellectual Property Rights (IPR) and IPR policy in India.
NEP07.CO2	Protect your innovative product and creative original work under Patent, Copy right, Trademark, Geographical Indication and Plant variety and Farmer's right.
NEP07.CO3	Protect your innovative product under Industrial Design/ Layout design of Integrated Circuit/Trade secret.

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F)   Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)					
	PO-1 An ability to independently carry out research /investigation and development work to solve practical problems.	**PO-2** An ability to write and present a substantial technical report/docu ment.	**PO-3** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	**PO-4** An ability to use different a dvanced software tools for analysis and design in the field of Green Tec hnology.	**PO-5** An ability to acquire professional and intellectual integrity, ethics of research and an understanding of responsibility to contribute to the community for sustainable development of society.	**PO-6** An ability to engage in life- long learning with a high level of commitment to improve know ledge and competence continuously.
NEP07.CO1	2	2	1	-	2	2
NEP07.CO2	2	2	1	1	2	2
NEP07.CO3	2	2	1	1	2	2

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G)   Teaching & Learning and Assessment Scheme:

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Component (TC)		Lab Instruction (LI)	Term Work (TW) + Self Learning (SL)	Total Hours (TC+LI+TW+ SL) (For 15 Weeks)	Total Credits (C)	Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
			Input (I)	Tutorial (T)					Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Term Work Assessment (PTWA)	End Term Work Assessment (ETWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
NEP07	NEP	Intellectual Property Rights (IPR)	15	-	-	15	30	01	25	-	25	-	-	-	50

H)   Course Curriculum Detailing: For attainment of course outcomes, the students are expected to perform/ undergo various activities through classroom, laboratories/ workshops/ term work, self-learning/ field sessions. As per the requirements of NEP 2020, unique features like green skills, multidisciplinary aspects, societal connect, IKS, renewable energy are integrated appropriately.

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I)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 1a. Explain the concept of Intellectual Property (IP) and Intellectual Property Right (IPR).	**Unit-1.0 Introduction to IP, IPR and its enforcement**	CO1
TSO 1b. Enlist the types of IPR and the type of protection it offers to a product.	1.1 IP and IPR – Concept, need and its significance	
TSO 1c. With the example of any product explain how the IPR is enforced on a product	1.2 Types of IPR – Patent, Copyright, Trademark, Geographical Indications, Industrial designs, Layout design of Integrated Circuit, trade secret, Traditional knowledge, Plant varieties and farmer's rights	
TSO 1d. Name the Legislations Covering different types of IPRs in India.	1.3 Enforcement of IP on a given product, Overlapping rights	
TSO 1e. Explain the need and significance of IPR policy in an Institution.	1.4 Legislations Covering IPRs in India	
TSO 1f. Differentiate between limited and unlimited IP with examples	1.5 IPR Policy – Need and significance 1.6 Limited life and Unlimited life IPS	
TSO 2a. Explain the need and significance of patent/Copyright/GI/ Plant variety and farmer's right/Traditional knowledge	**Unit-2.0 Patent, Copyright and related rights, Geographical Indications, Plant Varity and farmer's right, Traditional knowledge**	CO2
TSO 2b. Enlist the criteria for protection under patent/Copyright/GI/ Plant variety and farmer's right/Traditional knowledge	2.1 Patent - Need and significance of patent, patentable and non-patentable inventions, types of Patent, tenure, legislation and organization set up in India, fees and brief procedure of patent filling in India indicating every step, Infringement, Commercialization of a patent.	
TSO 2c. List the work protected under patent/Copyright/GI/ Plant variety and farmer's right/Traditional knowledge	2.2 Copyright and related rights - Need and significance of Copyright and related rights, entitlement to protection of copyright, works protected, tenure, legislation and organization set up in India, role of Copyright Board, copy right society, assignment and licensing, fees, brief procedure and infringement.	
TSO 2d. Mention the legislation set up in India and fees applicable for getting Patent/Copyright/GI/ Plant variety and farmer's right. Also mention the tenure of protection	2.3 Geographical Indications (GI)- Need and significance of GI, entitlement to protection of GI, works protected, classes of GI, tenure, legislation and organization set up in India and fees, Passing and infringement of GI.	
TSO 2e. Describe in brief every step of process of patenting/Copyright /GI with the help of a flowchart	2.4 Plant Variety & Farmer's Rights – Need and significance, entitlement to protection of plant varieties, register able plant varieties in India, Duration of protection for a registered new plant variety. 2.5 Traditional knowledge (TK) – Significance, Agreement on TK and its protection.	

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Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 3a. Explain the need and significance of Industrial Design/ Layout design of Integrated Circuit/Trademark/Trade secret.	**Unit-3.0 Layout design of Integrated Circuits Industrial Designs, Trademark and Trade secrets,**	CO3
TSO 3b. Enlist the criteria for protection under of Industrial Design/ Layout design of Integrated Circuit/ Trademark/Trade secret.	3.1 Layout design of Integrated Circuits - Need and significance of protection of layout designs for Integrated Circuits. entitlement to protection, works protected, tenure, legislation and organization set up in India and fees, and Infringement.	
TSO 3c. List the work protected under Industrial Design/ Layout design of Integrated Circuit/Trademark/Trade secret.	3.2 Industrial Designs - Need and significance of Industrial Designs, entitlement to protection of designs, works protected, tenure, who can apply, legislation and organization set up in India and fees, Infringement of design right.	
TSO 3d. Mention the legislation set up in India, fees, tenure infringement and remedies applicable for getting Industrial Design/ Layout design of Integrated Circuit, also mention the tenure of protection	3.3 Trademark – Need and significance, Types of trademark, entitlement to protection of trademark, tenure, legislation and organization set up in India and fees, who can apply, Procedure for filing application for Trademark, Passing and infringement of trademark.	
TSO 3e. Explain the strategies to protect trade secret in India with 2 examples	3.4 Trade secret- Need and significance of Trade secret protection. entitlement to protection, works protected, tenure, legislation and organization set up in India and fees, strategies to protect trade secret in India.	

J)   Suggested Laboratory Experiences: (Not Applicable)

K)   Suggested Research Based Problems

Note: Depending on the requirement of each laboratory experience, micro project and research-based problems, the performance may be conducted in online/offline mode and accordingly appropriate assessment tools may be used.

L)   Suggested Term Work (TW):

a.   Assignment(s):

Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

- A product is always protected simultaneously by more than one type of IPR and there is always the overlapping of rights. Considering the example of purple pill or any other product, highlight the enforcement of IP particularly Patent, Copyright, Trademark, design, and trade secret.

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- Mr. Ram has created and designed an innovative website. Analyze the appropriate protection mechanism/s for that website.
- Is certification mark different from collective mark? Analyze and answer
- Who can register geographical indication in India?
- Is it possible to register the shape and configuration of a shock absorber under Industrial Design act in India? Analyze and answer
- What is the need of protection of IC Layout design?
- Differentiate between assignment and licensing in case of Copyright.
- Whether attributes of patented product can be protected by trade-secret? Analyze and answer
- Describe strategies used to protect trade secrets in Research Organizations and software companies.

M)   Suggested Specification Table for End Semester Theory Assessment (ETA): (Not Applicable)

N)   Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately used in online and offline mode, as per the requirement of the outcome to be achieved. Some of them are improved lecture, tutorial, case method, group discussion, industrial visits, industrial training, field trips, portfolio based, learning, role play, live demonstrations in classrooms, lab, field information and communications technology (ICT)based teaching learning, blended or flipped mode, brainstorming, expert session, video clippings, use of open educational resources (OER), MOOCs etc. To ensure learning, research-based problems may be designed and implemented.

O)   Major Equipment, Tools and Software for Laboratory and Research Work: (Not Applicable)

P)   Suggested Learning Resources:

   a) **Books**

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers	Ramakrishna B and Anil kumar H.S.	Notion Press, 1 January 2017 ISBN-10 1946556319 ISBN-13 978-1946556318
2.	Intellectual Property Law	Narayan P.	Eastern Law House Private Ltd 1 January 2001, ISBN-10 8171772684 ISBN-13 978-8171772681
3.	Intellectual Property Rights: Text and Cases	Radhakrishnan R., Balasubramanian S	Excel Books July 30, 2008 July 30, 2008, ISBN-10: 8174466096 ISBN-13: 978-8174466099
4.	Law Relating to Intellectual Property	Wasehra B. L	Universal Law Publishing January 2016, ISBN-13 978-9350350300
5.	Intellectual Property Law	Meenu Paul	Allahabad Law Agency, ISBN-10: 8190286714, ISBN-13 : 978-8190286718
6.	Law of Intellectual Property	Myneni S. R.	Asia Law House (1 January 2019) ISBN-10: 9388437233 ISBN-13: 978-9388437233

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b) Online Educational Resources (OER):

1) https://ipindia.gov.in/
2) https://nptel.ac.in/courses/109106137
3) https://books.openedition.org/iheid/652?lang=en

Others:
1) E book - https://dst.gov.in/sites/default/files/E-BOOK%20IPR.pdf
2) WIPO Intellectual Property Handbook
3) The Intellectual Property Handbook: A Practical Guide for Franchise, Business, and IP
4) Counsel Second Edition by Christopher P. Bussert, James R. Sims III
5) IPR Handbook for Pharma Students and Researchers Parikshit Bansal, Pharma Med Press, 2015
6) https://www.kaggle.com/rohankayan/years-of-experience-and-salary-dataset

Q) Course Curriculum Developer

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16. Annexure

16.1 Common Courses across the all M. Tech., MBA and M.Sc. programmes

S. No.	Common Courses Title
1.	Basics of Artificial Intelligence and Machine Learning
2.	Sports, Yoga & Meditation
3.	Open Educational Resources
4.	Professional Ethics
5.	Financial Literacy
6.	Engineering Economics
7.	Project
8.	Research Methodology
9.	Curriculum & Assessment
10.	Indian Knowledge System (IKS)
11.	Dissertation Part -I
12.	Dissertation Part - II
13.	MOOC Creation
14.	Learner Centric Instructional Methods
15.	Intellectual Property Rights (IPR)

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