Curriculum

M.Tech Transportation Engineering & Management

July, 2025

School of
Engineering and Technology

Department of
Civil and Environmental 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
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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.

20/8/25

Prof. (Dr.) Chandra Charu Tripathi,
Project Director
NITTTR, Bhopal

2. Introduction:

The M.Tech. in Transportation Engineering and Management offered by the Department of Civil Engineering, NITTTR Bhopal, is a transformative postgraduate program tailored for working professionals, in-service educators, and motivated learners aiming to specialize in sustainable and intelligent transportation systems. The curriculum is meticulously crafted in line with the National Education Policy (NEP) 2020, National Credit Framework (NcRF), and emerging global educational paradigms, providing a dynamic and flexible structure with multiple entry and exit points, and the provision for recognition of prior learning (RPL).

This program fosters a multidisciplinary and holistic education that emphasizes hands-on learning, real-world application, and innovative pedagogies. Students will acquire expertise in core and emerging domains of transportation engineering, including transportation planning, traffic operations, project management, and cutting-edge technologies like Artificial Intelligence (AI), Machine Learning (ML), Intelligent Transportation Systems (ITS), and data-driven analytics. In alignment with national priorities such as the Bharatmala Pariyojana, the curriculum prepares learners to engage with mega-infrastructure projects, sustainability challenges, smart mobility solutions, and the digital transformation of transport systems. The program ensures that graduates are equipped with the technical, managerial, and ethical competencies needed for leadership roles in academia, research, industry, and public administration.

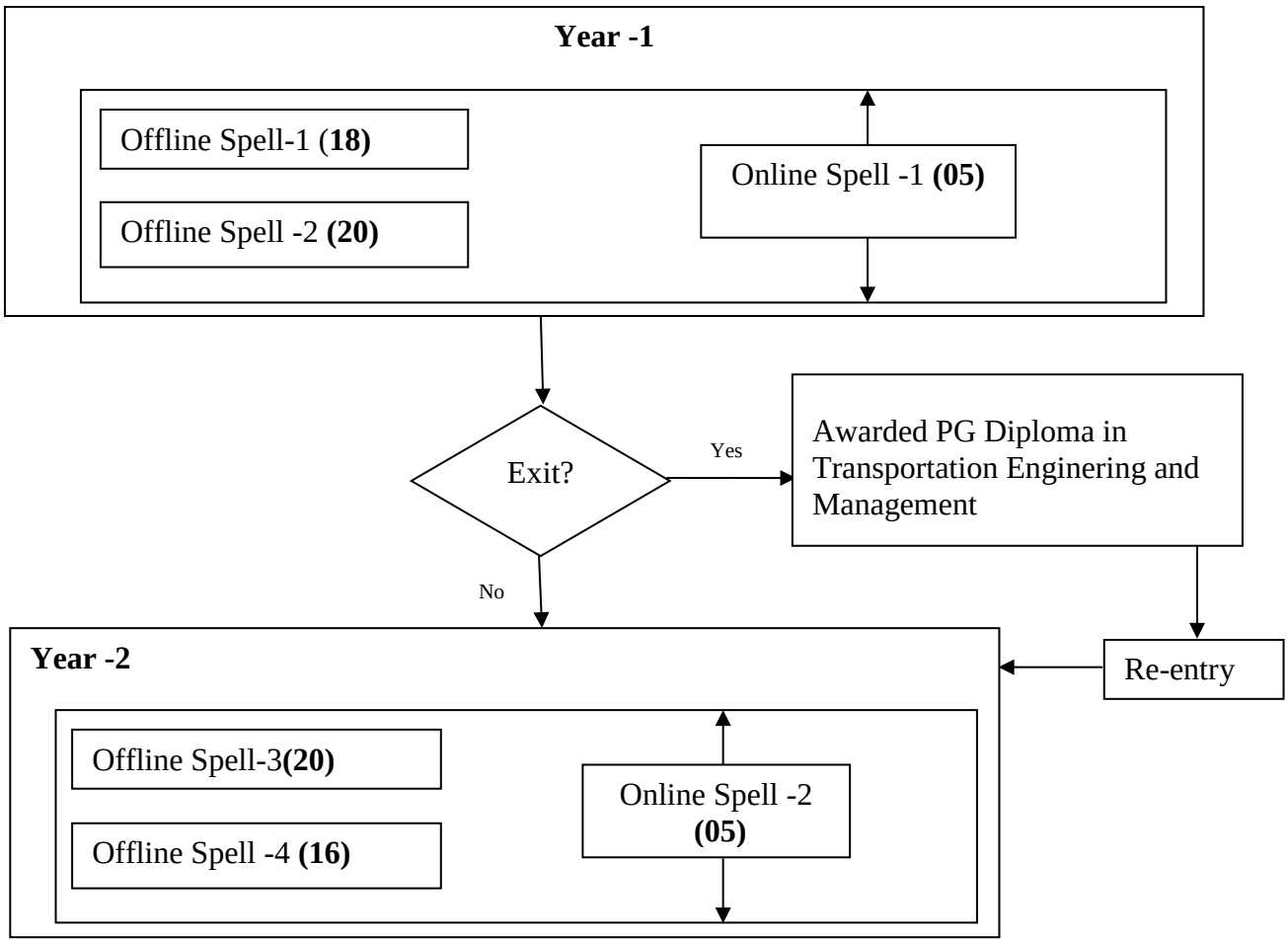
3. Approach for Scientific Design & Development of Curriculum:

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.

6. Vision & Mission Statements of the Department:

Vision:

To be a nationally acknowledged centre of excellence in Civil and Environmental Engineering, promoting research, innovation, and capacity building for a sustainable and technologically empowered future, consistent with the vision of the Institute.

Mission:

- Offer flexible and demand-driven education programs through offline, online, and hybrid models.
- Conduct interdisciplinary and applied research that addresses infrastructure, environment, and social challenges.
- Design outcome-based and futuristic curricula in civil engineering and allied domains.
- Deliver high-quality consultancy and knowledge-based services to the public and private sectors.
- Promote sustainable practices, ethical engineering, and community-oriented solutions.
- Build linkages with global academic and industry partners to enrich the department's ecosystem.

7. Programme Educational Objectives (PEOs): Learners of this program will be able to:

PEO1: Build a successful technical, teaching, or managerial career in academic institutions, government departments, and private sector industries.

PEO2: Pursue advanced studies, certifications, and continuous skill development in transportation engineering and related fields.

PEO3: Build successful businesses, startups, and entrepreneurial activities

8. Programme Outcomes (POs):

PO1 An ability to independently carry out research /investigation and development work to solve practical problems.

PO2 An ability to write and present a substantial technical report/document.

PO3 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.

9. Employment Potential:

Sample Employment and self-employment avenues are mentioned below-

9.1. Employment Avenues:

- Transportation Engineer
- Intelligent Transportation System (ITS) Specialist
- Public Transport Systems Manager
- AI/ML Transportation Analyst
- Transport Infrastructure Consultant
- Project Manager (Transportation Projects)

9.2. Self-Employment Avenues:

- Consultant Transportation Systems
- Startups/Business

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

1.	**Title of Programme**	:	M. Tech. in Transportation Engineering and Management
2.	**Board of Studies**	:	Transportation Engineering and Management
3.	**Duration of Programme**	:	Two Years
4.	**Entry Qualification**	:	B. Tech./ B.E.
5.	**Total Marks**	:	81
6.	**Total Credits**	:	3610
7.	**Total Number of Courses**	:	23

Summary of Credits and Marks

S. No	Spell	Credits	Total Marks
Year -1			
1.	Offline Spell - 1	18	750
2.	Offline Spell –2	17	680
3.	Online Spell – 1 (PD& NEP)	05	250
Total		**40**	**1680**
Year-2			
4.	Offline Spell - 3	20	880
5.	Offline Spell - 4	16	800
6.	Online Spell – 2 (PD & NEP)	05	250
Total		**41**	**1930**
Grand Total		**81**	**3610**

Category wise Courses

S. No.	Course Category	Abbreviations	Number of Courses	Total Credits
1.	Programme Core Courses	PCC	07	23
2.	Programme Elective Courses	PEC	03	09
3.	Stream Specific Diversified Courses (if applicable)	SSC	-	-
4.	Open Elective Courses (Common Basket)	OEC	03	09
5.	Project, Dissertation	PD	03	29
6.	Pedagogy Courses	PC	04	08
7.	NEP Courses	NEP	03	03
Total			**23**	**81**

Transportation Engineering and Management- TEM

Teaching & Learning and Assessment Scheme (Year – 1)

Offline Spell – 1

Course Code	Course Category	Course Titles	Teaching & Learning Scheme (Hours)						Assessment Scheme (Marks)							
			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)	
TEM01	PCC	**Modern Transportation Systems**	30	15	-	45	90	03	30	40	50	-	-	-	120
TEM02	PCC	**Finite Element Method**	45	15	15	45	120	04	30	40	50	-	30	20	170
TEM03	PCC	**Pavement Design & Evaluation**	30	15	30	15	90	03	30	30	20	-	30	10	120
TEM04	OEC	**Open Elective Course**	30	15	-	45	90	03	30	40	50	-	-	-	120
CSEB05	PCC	**Basics of Artificial Intelligence and 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**	**75**	**90**	**195**	**540**	**18**	**175**	**220**	**215**	**-**	**80**	**60**	**750**

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)

Open Elective Course: Project Management (TEM04)
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

***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)	
TEM05	PCC	**Traffic Engineering & Management**	30	15	-	45	90	03	30	40	50	-	-	-	120
TEM06	PCC	**Geometric Design of Transportation Systems**	30	15	-	45	90	03	30	40	50	-	-	-	120
TEM07-15	PEC	**Program Elective Courses**	-	-	-	-	90	03	-	-	-	-	-	-	120
TEM04	OEC	**Open Elective Courses**	30	15	-	45	90	03	30	40	50	-	-	-	120
PD01	PD	**Project**	-	-	45	105	150	05	-	-	200	-	-	-	200
Total			**90**	**45**	**45**	**240**	**510**	**17**	**90**	**120**	**350**	**-**	**-**	**-**	**680**

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 Courses: Railway Engineering (TEM07)/ Airport Engineering (TEM08)/ Advanced Geo-Technical Engineering (TEM09)/ Intelligent Transport Systems (TEM10)
Programme Elective Courses (Offering through MOOC): Pavement Construction Technology (TEM11) / Geometric Design of Transportation Systems (TEM12)/ Sustainable Transportation Systems (TEM13)/ Project Planning and Control (TEM14)/ Transport Network and Analysis (TEM15)

Open Elective Course: Project Management (TEM04)
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

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)

Year – 2

Offline Spell – 3

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)	
TEM16	PCC	**Transportation Project Planning and Management**	30	15	15	30	90	03	30	30	30	-	20	10	120
TEM07-15	PEC	**Program Elective Courses**	-	-	-	-	90	03	-	-	-	-	-	-	120
TEM07-15	PEC	**Program Elective Courses**	-	-	-	-	90	03	-	-	-	-	-	-	120
TEM04	OEC	**Open Elective Courses**	30	15	-	45	90	03	30	40	50	-	-	-	120
PD02	PD	**Dissertation Part - I**	-	-	90	150	240	08	-	-	300	100	-	-	400
Total			**60**	**30**	**105**	**225**	**600**	**20**	**60**	**70**	**380**	**100**	**20**	**10**	**880**

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 Courses: Railway Engineering (TEM07)/ Airport Engineering (TEM08)/ Advanced Geo-Technical Engineering (TEM09)/ Intelligent Transport Systems (TEM10)
Programme Elective Courses (Offering through MOOC): Pavement Construction Technology (TEM11) / Geometric Design of Transportation Systems (TEM12)/ Sustainable Transportation Systems (TEM13)/ Project Planning and Control (TEM14)/ Transport Network and Analysis (TEM15)

Open Elective Course: Project Management (TEM04)
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

Offline Spell – 4

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)	
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)

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)							
			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)	
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

A)	**Course Title:** Modern Transportation System	Deemed to be University under Distinct Category
B)	**Course Code:** TEM01	
C)	**Pre-requisite (s):** Transportation Engineering/Highway Engineering	

D) Rationale: The course Transportation engineering forms the backbone of modern infrastructure development and economic growth. This course provides students with comprehensive knowledge of contemporary transportation systems, emerging technologies, and sustainable practices. The curriculum covers fundamental principles of transportation planning, design, and management while emphasizing modern approaches, including intelligent transportation systems, sustainable mobility solutions, and data-driven decision making. Students will develop critical thinking skills to address current challenges in transportation infrastructure, traffic management, and environmental sustainability. The course integrates theoretical concepts with practical applications, preparing graduates to contribute effectively to the rapidly evolving transportation sector.

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
TEM01.CO1	Analyze fundamental principles and components of modern transportation systems.
TEM01.CO2	Evaluate contemporary transportation technologies and their applications.
TEM01.CO3	Analyze sustainable transportation solutions for urban and rural environments.
TEM01.CO4	Assess advanced analytical tools and software for transportation system analysis.
TEM01.CO5	Assess the environmental and socio-economic impacts of transportation projects.

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
TEM01.CO1	2	1	3
TEM01.CO2	3	2	3
TEM01.CO3	3	3	3
TEM01.CO4	2	2	2
TEM01.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)	
TEM01	PCC	Modern Transportation System	30	15	-	45	90	03	30	40	50	-	-	-	120

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. Trace the evolution of transportation systems from ancient times to the modern era. *TSO 1b.* Identify infrastructure elements and system components in transportation networks. *TSO 1c.* Compare characteristics and performance parameters of different transportation modes. *TSO 1d.* Examine the role of transportation in economic development and urbanization.	**Unit 1.0 Introduction to Transportation Systems** 1.1 Evolution of Transportation Systems: Historical development from ancient times to the modern era, impact of the industrial revolution, technological milestones in transportation. 1.2 Transportation System Components: Infrastructure elements (roads, railways, airports, ports), vehicles and rolling stock, control and communication systems, terminals and intermodal facilities. 1.3 Transportation Modes: Selection criteria, capacity, and performance parameters. 1.4 Transportation and Society: Role in economic development, urbanization impacts, social equity considerations, accessibility, and mobility concepts.	**CO1**
TSO 2a. Classify highway systems and apply geometric design principles. *TSO 2b.* Differentiate between flexible and rigid pavement structures and design methodologies. *TSO 2c.* Analyze accident patterns and evaluate safety countermeasures.	**Unit 2.0 Highway Transportation Systems** 2.1 Highway Classification and Design: Functional classification systems, geometric design principles, cross-sectional elements, horizontal and vertical alignment design. 2.2 Pavement Systems: Flexible and rigid pavement structures, material characterization, design methodologies, pavement management systems. 2.3 Highway Safety: Accident analysis techniques, safety audit procedures, countermeasure identification and evaluation, Vision Zero concepts.	**CO2**
TSO 3a. Categorize public transit modes and their operational characteristics. *TSO 3b.* Optimize transit route planning and scheduling methodologies. *TSO 3c.* Design transit infrastructure, including stations and maintenance facilities. *TSO 3d.* Measure service quality and cost-effectiveness of transit systems.	**Unit 3.0 Public Transportation Systems** 3.1 Public Transit Modes: Bus rapid transit systems, light rail transit, metro rail systems, monorail, and automated guideway systems. 3.2 Transit Planning and Operations: Route planning methodologies, scheduling optimization, fleet management, and passenger flow analysis. 3.3 Transit Infrastructure: Station design principles, maintenance facilities, power supply systems, signaling, and communication systems.	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	3.4 Performance Evaluation: Service quality measures, ridership analysis, cost-effectiveness evaluation, customer satisfaction metrics.	
TSO 4a. Develop ITS architecture frameworks and communication protocols. *TSO 4b.* Configure adaptive traffic control and incident management systems. *TSO 4c.* Simulate connected and autonomous vehicle technologies.	**Unit 4.0 Intelligent Transportation Systems** 4.1 ITS Architecture and Components: System architecture frameworks, communication protocols, data collection and processing systems, integration strategies. 4.2 Traffic Management Systems: Adaptive traffic control systems, incident detection and management, variable message signs, traffic surveillance technologies. 4.3 Connected and Autonomous Vehicles: Vehicle-to-infrastructure communication, autonomous vehicle technologies, mixed traffic scenarios, safety implications.	**CO4**
TSO 5a. Assess the carbon footprint and environmental impacts of transportation projects. *TSO 5b.* Promote sustainable mobility solutions and alternative fuel technologies. *TSO 5c.* Integrate green infrastructure and renewable energy systems. *TSO 5d.* Predict future transportation technologies and smart city integration	**Unit -5.0 Sustainable Transportation and Future Trends** 5.1 Environmental Impact Assessment: Noise pollution assessment, life cycle assessment of transportation projects. 5.2 Sustainable Mobility Solutions: Electric and hybrid vehicles, alternative fuel technologies, shared mobility concepts, active transportation modes. 5.3 Green Transportation Infrastructure: Sustainable pavement materials, energy-efficient lighting systems, renewable energy integration, green building certification. 5.4 Future Transportation Technologies: Hyperloop and high-speed rail, drone delivery systems, smart city integration, blockchain applications in transportation.	**CO5**

J) Suggested Laboratory Experiences: (Not Applicable)

K) Suggested Research-Based Problems

- Traffic Flow Optimization: Develop algorithms for adaptive traffic signal control at urban intersections.
- Sustainable Pavement Design: Research on recycled materials for pavement construction and their performance evaluation.
- Public Transit Accessibility: Study on improving accessibility for differently-abled passengers in existing transit systems.
- Smart Parking Systems: Design and implementation of IoT-based parking management systems.

- Electric Vehicle Infrastructure: Planning and optimization of charging station networks for electric vehicles.
- Transportation Safety Analysis: Application of machine learning techniques for accident prediction and prevention.
- Rural Transportation Solutions: Development of cost-effective transportation solutions for rural areas.
- Air Quality Assessment: Impact assessment of transportation policies on urban air quality.

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):

- **Case Study Analysis:** Comprehensive analysis of a major transportation project (planning, design, implementation, and evaluation).
- **Traffic Survey and Analysis:** Conduct traffic studies and propose improvement measures for a selected location.
- **Literature Review:** Critical review of recent research papers on emerging transportation technologies.
- **Sustainability Assessment:** Environmental impact assessment of a transportation project with mitigation measures.
- **Technical Report:** Comparative analysis of transportation systems in different cities/countries.

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 Introduction to Transportation Systems	06
CO2	Unit -2.0 Highway Transportation Systems	09
CO3	Unit -3.0 Public Transportation Systems	08
CO4	Unit -4.0 Intelligent Transportation Systems	08
CO5	Unit -5.0 Sustainable Transportation and Future Trends	09
Total		**40**

N) Suggested 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: (Not Applicable)

P) Suggested Learning Resources:

a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Transportation Engineering	Dr. L.R. Kadiyali	Khanna Publishers ISBN: 978-8174090232
2.	Highway Engineering	Dr. S.K. Khanna and Dr.C.E.G. Justo	Nem Chand & Bros ISBN: 978 8122407747
3.	Transportation Engineering and Planning	Dr. Satish Chandra and Dr. M.M. Agarwal	PHI Learning ISBN: 978-8120336094
4.	Principles of Transportation Engineering	Dr. Partha Chakroborty and Dr. Animesh Das	PHI Learning ISBN: 978-8120338197

b) Online Educational Resources (OER):

1) "Transportation Engineering" by Prof. Tom V. Mathew (IIT Bombay): https://nptel.ac.in/courses/105/101/105101087/
2) "Urban Transportation Planning" by Prof. Ashish Verma (IISc Bangalore): https://nptel.ac.in/courses/105/108/105108087/
3) "Highway Engineering" by Prof. Animesh Das (IIT Kharagpur): https://nptel.ac.in/courses/105/105/105105108/
4) "Traffic Engineering and Management" by Prof. P. Vedagiri (IIT Madras): https://nptel.**ac**.in/courses/105/106/105106181/
5) "Transportation Systems Engineering" by Prof. Lelitha Vanajakshi (IIT Madras): https://nptel.ac.in/courses/105/106/105106182/

Q) Course Curriculum Development Team

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A)	**Course Title:** Finite Element Method	Deemed to be University under Distinct Category
B)	**Course Code:** TEM02	
C)	**Pre-requisite (s):** Strength of Materials	

D) Rationale: Finite Element Method (FEM) is a very popular numerical technique to analyse a wide range of structures across various disciplines ranging from civil, mechanical, aerospace, to biomechanics, etc. This method is a highly versatile tool, especially for problems that consist of generalized geometry, materials, loading, and boundary conditions. In this course fundamental concepts underlying the FEM are explained in detail. A general frame work of FEM procedure at element level and assembly level will be taught. Gauss Quadrature numerical schemes are used for the evaluation of stiffness matrices and force vectors. A detailed step-by-step analysis will be demonstrated for various types of elements. Algorithms and flowcharts will be used to explain FE program development using MATLAB/Python. Hands-on sessions are conducted on commercial FEA software to illustrate various analyses.

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
TEM02.CO1	Apply the Rayleigh-Ritz method to solve the various continuum structural problems.
TEM02.CO2	Apply finite element analysis to solve various 3-D linear elastic static problems.
TEM02.CO3	Formulate element stiffness matrices for various problems.
TEM02.CO4	Evaluate numerical schemes for the solution of various systems of equations.
TEM02.CO5	Predict the behavior of 1D and 2D structural systems involving various bars, beams, and plates.

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
TEM02.CO1	2	1	3
TEM02.CO2	3	2	3
TEM02.CO3	3	3	3
TEM02.CO4	2	2	2
TEM02.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)						
			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)	
TEM02	PCC	Finite Element Method	45	15	15	45	120	04	30	40	50	-	30	20	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. Identify the geometry, material properties, loads, and boundary conditions in a given structural problem. *TSO 1b.* Explain the relationship between thermal, structural, and electrical analogies in 1D systems. *TSO 1c.* Explain the significance of the kinematic, constitutive, and equilibrium equations in structural analysis. *TSO 1d.* Differentiate between plane stress, plane strain, and axisymmetric cases. *TSO 1e.* Use the principle of minimum potential energy to find the equilibrium configuration of the given simple structure. *TSO 1f.* Explain the role of virtual work in solving structural problems. *TSO 1g.* Apply key principles to solve the given continuum problems using the Finite Element Method (FEM).	**Unit 1.0 Mathematical Models and Approximations** 1.1 Basic ingredients of structural analysis (geometry, material, loads, and boundary conditions) 1.2 Thermal-structural-electrical analysis 1D analogy 1.3 Governing equations for structural analysis (kinematics, constitutive law, equilibrium equations) 1.4 Governing equations for 2D cases: Plane stress, Plane strain, and axisymmetric 1.5 Principle of minimum potential energy 1.6 Rayleigh-Ritz method 1.7 Principle of virtual work. 1.8 Philosophy of solving continuum problems using the Finite Element Method.	**CO1**
TSO 2a. Explain the procedure of finite element formulation for the given 3-D linear elastic static problem. *TSO 2b.* Use shape functions to derive displacement approximations for simple elements in the given finite element model. *TSO 2c.* Explain the role of each component (stiffness matrix, load vector, displacement vector) in the finite element analysis process. *TSO 2d.* Apply the principles of shape functions, stiffness matrix, and boundary conditions to the given finite element model to find a solution.	**Unit 2.0 Linear Finite Element Procedures in Solid Mechanics** 2.1 Finite element formulation for 3-D linear elastic statics. 2.2 Shape functions or interpolation functions. 2.3 Stiffness matrix, load vector, and displacement vector formulation. 2.4 Properties of the stiffness matrix. 2.5 Application of different types of boundary conditions to a system of equations.	**CO2**
TSO 3a. Compute shape functions for the elements in 1D, 2D, and 3D domains. *TSO 3b.* Apply graphical representations of shape functions and explore refinement techniques (h-refinement and p-refinement). *TSO 3c.* Derive 1D shape functions for the given finite element problems. *TSO 3d.* Plot shape functions for the given 1D, 2D, and 3D elements. *TSO 3e.* Implement h and p-refinement strategies in the given finite element problems.	**Unit 3.0 Computation of element matrices and vectors** 3.1 Shape or Interpolation function for rectangular and triangular elements in 2D. 3.2 Shape or Interpolation function for hexahedral and tetrahedral elements in 3D. 3.3 Shape or Interpolation function for 1D elements.	**CO3, CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 3f. Explain the mapping process in finite element analysis. *TSO 3g.* Formulate element stiffness matrices using 1D, 2D, and 3D mapped elements.	3.4 Graphical representation of shape functions. 3.5 h-refinement and p-refinement. 3.6 Mapping of elements: geometry and displacement fields. 3.7 Element stiffness using mapped elements: 1D, 2D, and 3D.	
TSO 4a. Explain the numerical integration schemes and Gauss quadrature process for the given 1D, 2D, and 3D elements. *TSO 4b.* Apply the Gauss elimination method to solve linear systems of equations efficiently. *TSO 4c.* Implement sparse matrix storage schemes for a given finite element problem.	**Unit 4.0 Numerical Schemes** 4.1 Numerical integration schemes. 4.2 Gauss Quadrature: Gauss points and weights for 1D, 2D, and 3D elements. 4.3 Gauss elimination method for solving a linear system of equations. 4.4 Sparse matrix and storage schemes.	**CO4**
TSO 5a. Develop finite element formulations for the given structural members, such as bars/beams/ and plates. *TSO 5b.* Explain each step in the assembly process of the given finite element model. *TSO 5c.* Implement a numbering scheme for the given simple finite element model.	**Unit -5.0 Finite Element Analysis of Structural Members** 5.1 Finite element formulation of bar. 5.2 Finite element formulation of the beam. 5.3 Finite Element Formulation of Plate. 5.4 Assembly process. 5.5 Numbering scheme.	**CO5**

J) Suggested Laboratory Experiences:

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant COs Number (s)
LSO 1.1 : Draw Bending moment and shear force diagrams, and identify the point of contraflexure for various loading and boundary conditions.	1.	Calculate bending moments and shear forces in 1D Beam Analysis.	CO1
LSO 2.1 : Evaluate displacements, strains, and stresses in a given structural member.	2.	Find displacement, strain, and stresses in a one-dimensional bar/beam under axial/transverse loading using a Virtual lab.	CO2 & CO5
LSO 3.1 :Analysis of various element types for a given structural element/member.	3	Compare the performance of finite elements (1D beam, 2D plate, etc.) subjected to various loading and boundary conditions.	CO3 & CO4
LSO 4.1 : Evaluate displacements, strains, and stresses for a given plate problem.	4	Analyse a rectangular plate under plane stress or plane strain conditions.	CO5
LSO 5.1 :Analyze products for a given loading conditions.	5.	Perform static analysis to study the behavior of products under mechanical and thermal loads.	CO2

K) Suggested Research-Based Problems

i. Multi-physics analysis of soft-gripper.
ii. Analysis of green composites
iii. Generative AI

L) Suggested Term Work (TW):

a. Assignment(s):

- Derive 3D governing equations in cylindrical coordinate system
- Derive the 3D constitutive law for isotropic material
- Derive shape functions for 2D element
- Draw the shape functions for four noded rectangular element
- Derive Gauss quadrature sampling points and weights for triangular element

b. Seminar Topics:

- Analysis and design of Metamaterials
- AI & ML and FEA
- Topology optimization

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 Mathematical Models and Approximations	08
CO2	Unit 2.0 Linear finite element procedures in solid mechanics	08
CO3	Unit 3.0 Computation of element matrices and vectors	08
CO4	Unit 4.0 Numerical schemes	08
CO5	Unit 5.0 Finite Element Analysis of Structural Members	08
Total		**40**

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.	Desktop/Laptop	Processor Intel Core i5, 4 GB RAM, 15 GB free disk space	All
2.	MATLAB	S/w to be downloaded for Python 3.11.3 or higher	All
3.	Mathematica	Symbolic Computation and Modeling	All

P) Suggested Learning Resources:

a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Finite Element Analysis	C.S. Krishnamoorthy	Publisher: McGraw Hill Education Edition: 2, 2017, ISBN: 9780074622100
2.	The Finite Element Method in Engineering	S.S. Rao	Publisher: Elsevier Edition: 6, 2019 ISBN: 935107384X
3.	The Finite Element Method using MATLAB	Young W. Known	Publisher: CRC Press Edition: 2, 2007 ISBN: 978-0495084969

b) Online Educational Resources (OER):

1) Basics of Finite Element Analysis-I, IIT Kanpur
   https://nptel.ac.in/courses/112104193
2) Finite Element Analysis, IIT Kharagpur
   https://nptel.ac.in/courses/105105041
3) Finite Element Method: Variational Methods to Computer Programming, IIT Guwahati
   https://nptel.ac.in/courses/112103295
4) Finite Element Method for Vibration and Stability Analyses, IISc Bangalore
   https://nptel.ac.in/courses/105108141

Q) Course Curriculum Development Team

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A)	**Course Title:** Pavement Design & Evaluation	Deemed to be University under Distinct Category
B)	**Course Code:** TEM03	
C)	**Pre-requisite (s):** Transportation Engineering/Highway Engineering	

D) Rationale: The course "Pavement Design & Evaluation" forms the cornerstone of transportation infrastructure engineering, addressing one of the most critical components of highway systems that directly impacts economic development, safety, and sustainability. With India's rapidly expanding highway network under ambitious infrastructure programs like Bharatmala and the increasing emphasis on quality infrastructure development, there is an urgent need for transportation engineers who possess advanced competencies in pavement design, analysis, and evaluation methodologies. The course addresses current industry challenges, including pavement deterioration mechanisms, climate change impacts on pavement performance, recycling technologies, and the integration of smart materials in pavement construction. Students will develop expertise in advanced analytical tools, performance evaluation techniques, and maintenance strategies that are essential for managing India's extensive road network efficiently and sustainably. The curriculum emphasizes research-oriented learning, encouraging students to investigate innovative solutions for pavement engineering challenges specific to Indian conditions, including monsoon effects, varied soil conditions, and heavy traffic loading scenarios.

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
TEM03.CO1	Analyze pavement materials and their behavior under various loading and environmental conditions using advanced testing techniques.
TEM03.CO2	Design flexible and rigid pavements using mechanistic-empirical methods and modern design standards.
TEM03.CO3	Apply non-destructive testing and performance monitoring to assess existing pavements.
TEM03.CO4	Develop pavement management systems with maintenance strategies, rehabilitation methods, and life-cycle cost analysis.
TEM03.CO5	Use computational tools for pavement analysis, design optimization, and performance prediction.

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
TEM03.CO1	3	2	3
TEM03.CO2	3	3	3
TEM03.CO3	3	2	3
TEM03.CO4	3	3	3
TEM03.CO5	2	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)	
TEM03	PCC	Pavement Design & Evaluation	30	15	30	15	90	03	30	30	20	-	30	10	120

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. Evaluate aggregate properties using advanced testing and characterization methods. *TSO 1b.* Select appropriate binders for specific applications. *TSO 1c.* Design concrete mixes for rigid pavement applications, considering durability requirements.	**Unit 1.0 Advanced Pavement Materials and Characterization** 1.1 Aggregates: Mineralogy, image-based shape analysis, durability, gradation, and advanced testing. 1.2 Bituminous Materials: Bitumen chemistry, rheology, aging, modified binders, and advanced tests (DSR, BBR, MSCR). 1.3 Cement & Concrete: Cement types, hydration, mix design, SCMs, fiber-reinforcement, and quality control.	**CO1**
TSO 2a. Apply stress-strain analysis for multi-layer pavement systems. *TSO 2b.* Characterize traffic loading and determine design parameters. *TSO 2c.* Integrate climatic factors in pavement design methodology.	**Unit 2.0 Mechanistic-Empirical Pavement Design Principles** 2.1 Stress Analysis, Elastic theory, FEA, dynamic loading, and fatigue. 2.2 Traffic Loading: ESALs, load spectra, tire interaction, and data collection. 2.3 Climatic Factors: Thermal and moisture effects, drainage, and environmental modeling.	**CO2**
TSO 3a. Compare empirical and mechanistic design approaches. *TSO 3b.* Design flexible pavement systems using modern methodologies. *TSO 3c.* Optimize layer thickness and material selection.	**Unit 3.0 Flexible Pavement Design Methodologies** 3.1 Empirical Methods: CBR, group index, and AASHTO methods. Modern Design: Superpave, layer design, volumetric and performance-based specs. 3.2 Advanced Concepts: Industrial and airport pavements, perpetual pavement, fatigue/rutting resistance. Special Conditions: Weak soils, frost, overlays, and reflective crack control..	**CO3**
TSO 4a. Analyze stress distribution in concrete pavement slabs. *TSO 4b.* Design joint systems and reinforcement details. *TSO 4c.* Evaluate advanced concrete pavement technologies.	**Unit 4.0 Rigid Pavement Design And Analysis** 4.1 Design Theory: Westergaard's theory, joints, slab thickness, and reinforcement. 4.2 Joint Systems: Types of joints, dowel/tie bars, sealing, and performance. 4.3 Advanced Technologies: RCC, pre-cast slabs, white topping, and pervious concrete..	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 5a. Implement non-destructive testing methods for pavement evaluation. *TSO 5b.* Assess structural capacity using various evaluation techniques.	**Unit -5.0: Pavement Evaluation And Testing Technologies** 5.1 Non-Destructive Testing Methods**:** Falling Weight Deflectometer (FWD) testing principles, deflection basin analysis, and back-calculation techniques. Ground Penetrating Radar (GPR) applications, layer thickness determination, and condition assessment. Spectral Analysis of Surface Waves (SASW), Multi-channel Analysis of Surface Waves (MASW), and seismic methods for stiffness evaluation. 5.2 Structural Evaluation Techniques**:** Pavement structural capacity assessment, remaining life estimation, and load rating procedures. Dynamic Cone Penetrometer (DCP) testing, Light Weight Deflectometer (LWD) applications, and portable testing equipment. Core extraction and analysis, laboratory testing protocols, and field-laboratory correlation studies.	**CO5**

J) Suggested Laboratory Experiences:

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number (s)
LSO 1.1. Execute standardized material testing procedures with precision. *LSO 1.2.* Evaluate material suitability. *LSO 1.3.* Compare material properties with specification requirements.	1.	Advanced Material Characterization • Scope: Comprehensive testing of pavement materials including aggregate gradation analysis, Los Angeles abrasion test, impact value determination, specific gravity measurements, and bitumen penetration, ductility, and softening point tests.	CO1
LSO 2.1. Perform systematic mix design procedures. *LSO 2.2.* Optimize mix proportions for performance requirements. *LSO 2.3.* Evaluate mix properties using advanced testing methods.	2.	Asphalt Mix Design and Evaluation • Scope: Marshall mix design procedure, optimum bitumen content determination, stability and flow measurements, density and void analysis, modified Marshall testing for polymer-modified bitumen, and Superpave gyratory compaction.	CO1
LSO 3.1. Design concrete mixes for specific pavement application. *LSO 3.2.* Evaluate fresh and hardened concrete properties.	3.	Concrete Mix Design for Rigid Pavements • Scope: Concrete mix design using absolute volume method, workability testing, compressive strength evaluation, flexural strength testing, modulus of elasticity	CO4

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number (s)
LSO 3.3. Assess durability characteristics for long-term performance.		determination, and durability assessment through rapid chloride permeability test.	
LSO 4.1. Operate advanced testing equipment effectively. *LSO 4.2.* Interpret test data for structural and functional evaluation. *LSO 4.3.* Develop assessment reports with recommendations.	4.	Non-Destructive Pavement Testing • Scope: Falling Weight Deflectometer (FWD) operation and data analysis, Ground Penetrating Radar (GPR) layer thickness measurement, Dynamic Cone Penetrometer (DCP) testing, roughness measurement using profilometer, and friction testing using British Pendulum Tester.	CO5
LSO 5.1. Conduct systematic pavement condition surveys *LSO 5.2.* Quantify distress severity and extent *LSO 5.3.* Correlate field observations with performance models	5.	Pavement Performance Evaluation • Scope: Distress survey and classification, pavement condition index calculation, structural capacity assessment, remaining life estimation, and development of maintenance recommendations based on evaluation results.	CO5

K) Suggested Research-Based Problems

i. **Development of Performance Prediction Models**
Research Focus: Develop locally calibrated performance prediction models for Indian climatic and traffic conditions using artificial intelligence and machine learning techniques. Investigate the integration of IoT sensors for real-time performance monitoring and adaptive model updating.

ii. **Sustainable Material Innovations**
Research Focus: Investigate the utilization of agricultural waste, industrial by-products, and recycled materials in pavement construction. Develop bio-based modifiers for asphalt binders and evaluate their performance under Indian environmental conditions.

iii. **Climate Change Impact Assessment**
Research Focus: Analyze the impact of changing climate patterns on pavement performance in different regions of India. Develop adaptation strategies and modify design methodologies to account for extreme weather events and temperature variations.

iv. **Smart Pavement Technologies**
Research Focus: Explore the integration of renewable energy generation, wireless charging systems, and traffic monitoring capabilities in pavement infrastructure. Investigate the feasibility and cost-effectiveness of smart pavement implementations in the Indian context.

v. **Advanced Recycling Technologies**
Research Focus: Develop innovative techniques for 100% recycling of aged pavement materials. Investigate cold recycling methods, rejuvenator effectiveness, and long-term performance of recycled pavement 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):

- **Material Property Evaluation and Selection**
  Comprehensive analysis of aggregates and binders from local sources, comparison with standard specifications, and recommendation for specific pavement applications based on traffic and environmental conditions.

- **Mechanistic-Empirical Design Project**
  Complete flexible pavement design using MEPDG approach for a specific project location, including traffic analysis, material characterization, environmental input determination, and performance prediction over design life.

- **Pavement Evaluation and Management Case Study**
  Comprehensive evaluation of an existing pavement section using multiple testing methods, condition assessment, remaining life estimation, and development of maintenance and rehabilitation strategies with economic analysis.

- **Sustainable Pavement Technology Research**
  Literature review and feasibility study of an emerging sustainable pavement technology, including environmental impact assessment, cost-benefit analysis, and implementation recommendations for Indian conditions.

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 Advanced Pavement Materials and Characterization	05
CO2	Unit 2.0 Mechanistic-Empirical Pavement Design Principles	05
CO3	Unit 3.0 Flexible Pavement Design Methodologies	06
CO4	Unit 4.0 Rigid Pavement Design and Analysis	07
CO5	Unit -5.0: Pavement Evaluation and Testing Technologies	07
Total		**30**

N) Suggested 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 i5, 4 GB RAM, 15 GB free disk space	All
2.	Universal Testing Machine (UTM)	Max. Load up to 200 tons	All
3.	Marshall Stability Apparatus	Capacity of 50 KN	All
4.	MATLAB	Data analysis, statistical modeling, and algorithm development	All

P) Suggested Learning Resources:

a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Pavement Engineering: Design, Construction, Maintenance	Dr. Sandipan Goswami	1st Edition (2021), PHI Learning Private Limited, ISBN-13: 9789391818104
2.	Pavement Design	R. Srinivasa Kumar	2013 Edition, Orient BlackSwan, ISBN-13: 9788173718854
3.	Concrete Pavement Design, Construction, and Performance	A. Delatte	CRC Press, ISBN: 978-0415471916
4.	Pavement Asset Management	Ralph Haas and W. Ronald Hudson	John Wiley & Sons, ISBN: 978-0470170434
5.	Sustainable Pavement Engineering	Hao Wang and Imad L. Al-Qadi	John Wiley & Sons, ISBN: 978-1118926284

b) Online Educational Resources (OER):

1) Mechanistic-Empirical Pavement Design Guide – FHWA Participant Workbook https://www.fhwa.dot.gov/pavement/materials/hmec/pubs/module_e/participant_workbook.pdf

2) Implementing the Mechanistic-Empirical Pavement Design Guide https://ctre.iastate.edu/wp-content/uploads/2018/03/mepdg_technical.pdf

3) An Introduction to Flexible Pavement Design – PDH Online https://pdhonline.com/courses/c369/c369content.pdf

4) Rigid Pavement Analysis and Design
https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/pccp/88068/88068.pdf

5) Flexible Pavement Evaluation for Effective Decision Making – ASCE
https://www.asce.org/education-and-events/explore-education/on-demand-webinars/flexible-pavement-evaluation-for-effective-decision-making

6) Sustainable Pavement Program – FHWA
https://www.fhwa.dot.gov/pavement/sustainability/epds/resources/

Q) Course Curriculum Development Team

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A)	**Course Title:** Project Management	Deemed to be University under Distinct Category
B)	**Course Code:** TEM04	
C)	**Pre-requisite (s):** Bachelor's degree in Civil Engineering or allied disciplines	

D) **Rationale:** Project Management forms the cornerstone of successful transportation infrastructure development, where complex multi-disciplinary projects demand sophisticated planning, execution, and control mechanisms. In India's rapidly expanding transportation sector, engineers must navigate diverse stakeholder requirements, resource constraints, and regulatory frameworks while delivering projects within specified time, cost, and quality parameters.

The course addresses the critical need for transportation engineers to develop advanced project management competencies essential for handling mega-infrastructure projects, such as highways, railways, airports, and urban transit systems. With an increasing emphasis on sustainable development, digital transformation, and public-private partnerships in transportation infrastructure, professionals require a comprehensive understanding of modern project management methodologies that are integrated with traditional Indian project delivery approaches.

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
TEM04.CO1	Evaluate project management methodologies for optimal selection in transportation infrastructure projects.
TEM04.CO2	Analyze project planning techniques to develop comprehensive project execution strategies.
TEM04.CO3	Design project monitoring and control systems for effective transportation project delivery.
TEM04.CO4	Evaluate risk management and quality assurance frameworks for transportation projects.

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
TEM04.CO1	2	1	3
TEM04.CO2	3	2	3
TEM04.CO3	3	2	2
TEM04.CO4	2	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)	
TEM04	OEC	Project Management	30	15	-	45	90	03	30	40	50	-	-	-	120

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. Define project management scope and applications. *TSO 1b.* Analyze transportation project lifecycle phases and deliverables. *TSO 1c.* Evaluate organizational structures for effective project governance.	**Unit 1.0 Fundamentals of Project Management** 1.1 Introduction to Project Management: Definition and scope of project management in the civil engineering context; Evolution of project management in the Indian transportation sector; Role of project managers in infrastructure development; Project vs. operations in transportation organizations. 1.2 Transportation Project Lifecycle: Project initiation and feasibility assessment; Planning and design phases; Construction and implementation; Operation and maintenance phases; Project closure and lessons learned. 1.3 Organizational Structures and Governance: Functional, matrix, and projectized organizational structures; Project governance frameworks; Roles and responsibilities of project stakeholders; Authority and accountability matrices.	**CO1**
TSO 2a. Evaluate comprehensive work breakdown structures for transportation projects. *TSO 2b.* Develop activity networks and dependency relationships. *TSO 2c.* Apply scheduling techniques for project time management.	**Unit 2.0 Project Planning and Scheduling** 2.1 Work Breakdown Structure (WBS) WBS development principles and techniques; Decomposition strategies for transportation projects; Work package definition and coding systems; WBS dictionary and documentation. 2.2 Activity Definition and Sequencing Activity identification and definition methods; Precedence diagramming method (PDM); Activity dependencies and relationships; Network diagram development. 2.3 Time Management and Scheduling Duration estimation techniques and methods; Critical Path Method (CPM) applications; Program Evaluation and Review Technique (PERT); Schedule compression and optimization techniques.	**CO2**
TSO 3a. Design performance measurement systems with appropriate KPIs. *TSO 3b.* Implement progress monitoring and reporting procedures.	**Unit 3.0 Project Monitoring and Control Systems** 3.1 Performance Measurement Systems Key Performance Indicators (KPIs) for transportation projects; Earned Value Management (EVM) principles; Performance	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 3c. Establish change management and configuration control processes.	dashboards and reporting systems; Baseline establishment and control. 3.2 Progress Monitoring and Reporting Progress measurement techniques and methodologies; Status reporting formats and procedures; Milestone tracking and variance analysis; Communication and stakeholder reporting. 3.3 Change Management and Configuration Control: Change request procedures and approval processes; Impact assessment and evaluation; Configuration management systems; Version control and document management.	
TSO 4a. Develop comprehensive risk management frameworks. *TSO 4b.* Implement quality management systems for project delivery.	**Unit 4.0 Risk Management and Quality Assurance** 4.1 Risk Management Framework: Risk management planning and strategy development; Risk identification techniques and tools; Risk assessment and prioritization methods; Risk response strategies and implementation. 4.2 Quality Management Systems: Quality planning and assurance frameworks; Quality control processes and procedures; Quality audits and inspections; Continuous improvement methodologies.	**CO4**

J) Suggested Laboratory Experiences: (Not Applicable)

K) Suggested Research-Based Problems

i. AI-Enhanced Project Scheduling: Development of machine learning algorithms for dynamic project scheduling optimization in transportation infrastructure projects.
ii. Sustainable Project Delivery Models: Research on integrating circular economy principles and carbon neutrality targets into transportation project management frameworks.
iii. Digital Twin Applications: Investigation of digital twin technology for real-time project monitoring and predictive analytics in highway construction projects.
iv. Stakeholder Engagement Optimization: Development of frameworks for effective community engagement and stakeholder management in urban transportation projects.
v. Risk Prediction Models: Creation of predictive models for risk assessment in transportation projects using historical data and machine learning techniques.

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):

- Project Planning Assignment: Develop a complete project plan for a hypothetical transportation infrastructure project, including WBS, schedule, and resource allocation.
- Risk Management Portfolio: Create a comprehensive risk management plan with identification, assessment, and mitigation strategies.
- Case Study Analysis: Detailed analysis of a major transportation project examining project management practices, challenges, and outcomes.
- Software Application Project: Hands-on project using project management software to demonstrate scheduling, resource management, and progress tracking.
- Industry Expert Interview Report: Report on interactions with practicing project managers discussing real-world challenges and solutions.

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: Fundamentals of Project Management.	08
CO2	Unit -2.0: Project Planning and Scheduling.	12
CO3	Unit -3.0: Project Monitoring and Control Systems.	09
CO4	Unit -4.0: Risk Management and Quality Assurance.	11
Total		**40**

N) Suggested 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: (Not Applicable)

P) Suggested Learning Resources:

a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Construction Project Management	K.K. Chitkara	Tata McGraw-Hill, ISBN: 978-0070635951

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
2.	Project Management: A Systems Approach to Planning, Scheduling, and Controlling	Harold Kerzner	John Wiley & Sons, ISBN: 978-1119165354
3.	Managing Construction Projects	Sidney M. Levy	Amacom, ISBN: 978-0814413463
4.	Project Management in Construction	S. Chand & Company	S. Chand & Company, New Delhi, ISBN: 978-8121926805
5.	Construction Management and Planning	P.S. Gahlot and Dhir Malhotra	New Age International Publishers, ISBN: 978-8122413083

b) Online Educational Resources (OER):

1) **"Project Management for Engineers"** - Prof. Arun Kanda, IIT Delhi
https://nptel.ac.in/courses/110102034

2) **"Construction Project Management"** - Prof. Bhargab Maitra, IIT Kharagpur
https://nptel.ac.in/courses/105105104

3) **"Project Planning and Control"** - Prof. N.R. Seeley, IIT Roorkee
https://nptel.ac.in/courses/105107085

4) **"Infrastructure Finance"** - Prof. Gayathri Krishnaswamy, IISc Bangalore
https://nptel.ac.in/courses/110108066

5) **"Transportation Systems Engineering"** - Prof. Tom V. Mathew, IIT Bombay
https://nptel.ac.in/courses/105101087

6) **"Highway Engineering"** - Prof. K.V. Krishna Rao, IIT Bombay
https://nptel.ac.in/courses/105101008

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A)	**Course Title:** Basics of Artificial Intelligence and Machine Learning	Deemed to be University under Distinct Category
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. *TSO 1b.* Explain the concept of Lvalue and Rvalue *TSO 1c.* Write Python program using various data types and operators *TSO 1d.* Write Python program using decision-making statements. *TSO 1e.* Write Python Program using loop structure to solve iterative problems.	**Unit-1.0 Basics of Python Programming** 1.1 Procedure oriented vs. Object-Oriented approach of programming 1.2 Python character set, Python tokens, variables, concept of Lvalue and Rvalue, use of comments. 1.3 Data types: number (integer, floating point, complex), Boolean, sequence (string, list, tuple), none, mapping (dictionary), mutable and immutable data types 1.4 Operators: arithmetic operators, relational operators, logical operators, assignment operator, augmented assignment operators. Expressions, statements, type conversion &	**CO1**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	input/output: precedence of operators, expressions, and evaluation of expressions. 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	**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	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
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 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.	method in Python, class and static variable, constructor and destructors in Python. 3.2 Inheritance: single, multiple, multilevel, hierarchical inheritances 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.	

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
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. *TSO 4d.* Explain the procedure for validating the machine learning algorithm.	**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 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.	**CO4**
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: a. If statements b. If-else statements, if-elif-else statements	CO1
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. Visualize the given data in various dimensions. *LSO 7.2.* 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

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number (s)
LSO 8.1. Apply Linear Regression and Multiple Linear Regression for predictive analysis. *LSO 8.2.* Evaluate the Linear and Multiple Linear Regression models with respect to the standard evaluation metrics.	8.	a) Perform the predictive analysis using Multiple Linear Regression. b) Perform the predictive analysis using Linear Regression. c) Compare the performance of the Multiple Linear Regression and Linear Regression with respect to the prediction accuracy and time.	CO4
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	13.	a) Implement the support Vector Machine (SVM) algorithm for image classification/ semantic segmentation (choose any dataset)	CO3, CO4

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number (s)
respect to the standard evaluation metrics. *LSO 13.3* Compare the performance of the SVM with MLP with respect to the standard evaluation metrics.		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.	
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
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	Deemed to be University under Distinct Category
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,	**CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	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	
TSO 3a. Describe the mental aspects of sports and performance. *TSO 3b.* Apply skills learned in sports, yoga, 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.	**Unit-3.0 Sports, Mental Conditioning and Integration** 3.1 Mental preparation techniques for sports 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	**CO3**

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

S. No.	Name of Equipment, Tools and Software	Broad Specifications
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
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

S. No.	Name of Equipment, Tools and Software	Broad Specifications
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
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

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
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)	Deemed to be University under Distinct Category
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,	**CO1**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	Repositories 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	Deemed to be University under Distinct Category
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: Group 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

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A)	**Course Title:** Financial Literacy	Deemed to be University under Distinct Category
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. *TSO 1d.* Explain the Cash Flow Management process for the given situation. *TSO 1e.* Explain Saving for household for the given situation. *TSO 1f.* Formulate the investment plan for the given individual. *TSO 1g.* Explain Inflation in the economy *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.	1.3 Budgeting & Cash Flow Management 1.4 Saving 1.5 Investing 1.6 Inflation & Interest Rates 1.7 Bank Accounts and Payment Methods 1.8 Credit Management 1.9 Debt Management 1.10 Insurance	
TSO 2a. Identify the various the Investment option and types for the given situation. *TSO 2b.* Building a Diversified Portfolio applying risk-return trade-off for the given situation. *TSO 2c.* Apply the Risk-Return Trade-off for the given situation. *TSO 2d.* Explain Informed Investment Decisions for the given situation. *TSO 2e.* Write the steps in Retirement Planning for the given situation. *TSO 2f.* Explain Social Security and Pensions for the given situation. *TSO 2g.* Identify the Investment Options for Retirement Savings for the given situation. *TSO 2h.* Make Plans for Unexpected Events for the given situation. *TSO 2i.* List the Filing Taxes and Forms	**Unit-2.0: Investing & Taxation** 2.1 Investment option and types 2.2 Building a Diversified Portfolio 2.3 Risk-Return Trade-off 2.4 Informed Investment Decisions 2.5 Retirement Planning 2.6 Social Security and Pensions 2.7 Estimating Future Retirement Expenses 2.8 Planning for a Comfortable Retirement 2.9 Investment Options for Retirement Savings 2.10 Planning for Unexpected Events 2.11 Filing Taxes and Forms 2.12 Tax Laws and Regulations 2.13 Minimizing Tax Liability 2.14 Making Tax-Effective Investment Decisions	**CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 2j. Outline the Tax Laws and Regulations. *TSO 2k.* Minimizing Tax Liability for the given situation. *TSO 2l.* Make Tax-Effective Investment Decisions for the given situation.		
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

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
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	Deemed to be University under Distinct Category
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	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)	
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	**CO1**
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?
- 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:** Traffic Engineering & Management	Deemed to be University under Distinct Category
B)	**Course Code:** TEM05	
C)	**Pre-requisite (s):** Transportation Engineering/Highway Engineering	

D) **Rationale:** This course provides a comprehensive understanding of traffic engineering principles, traffic flow theory, intersection design, traffic control systems, and traffic management strategies. The course focuses on developing analytical and design skills for efficient traffic operations, safety enhancement, and capacity optimization of transportation facilities. Students will learn modern traffic engineering practices, traffic simulation techniques, and sustainable traffic management approaches essential for contemporary urban transportation planning.

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
TEM05.CO1	Analyze traffic flow characteristics, driver behavior, and vehicle performance parameters using traffic flow theory and statistical methods.
TEM05.CO2	Design traffic control systems, including signals, signs, markings, and intersection layouts for efficient and optimised traffic operations.
TEM05.CO3	Evaluate traffic safety conditions to create countermeasures for accident reduction and traffic conflict minimization.
TEM05.CO4	Apply traffic management strategies for urban areas, including traffic calming, parking management, and congestion mitigation techniques.
TEM05.CO5	Utilize traffic simulation software and analytical tools for traffic analysis, capacity evaluation, and performance assessment.
TEM05.CO6	Demonstrate understanding of intelligent transportation systems (ITS) and sustainable traffic management practices.

F) 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
TEM05.CO1	3	2	3
TEM05.CO2	3	1	3
TEM05.CO3	3	1	3
TEM05.CO4	2	2	3
TEM05.CO5	2	2	3
TEM05.CO6	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)	
TEM05	PCC	Traffic Engineering & Management	30	15	-	45	90	03	30	40	50	-	-	-	120

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 fundamental traffic flow relationships and parameters. *TSO 1b.* Apply traffic flow models for capacity analysis. *TSO 1c.* Analyze driver behavior and vehicle performance characteristics.	**Unit 1.0 Traffic Flow Theory and Characteristics** 1.1 Fundamental Traffic Flow Parameters - Speed: time mean speed, space mean speed, design speed, operating speed, running speed, journey speed, Volume: traffic volume, peak hour volume, design hour volume, capacity, practical capacity, Density: traffic density, jam density, critical density, optimum density, Relationships between speed, volume, and density parameters, Level of Service (LOS) concepts and criteria for different facility types. 1.2 Traffic Flow Models and Relationships- Linear model, Logarithmic model, Exponential model, Comparison of different traffic flow models and their applicability, Capacity analysis using fundamental diagrams, Free flow speed and jam density determination. 1.3 Driver behavior characteristics: perception-reaction time, driver aggressiveness, Vehicle dynamics and performance parameters.	**CO1**
TSO 2a. Conduct various traffic studies and data collection . *TSO 2b.* Apply statistical methods for traffic data analysis. *TSO 2c.* Forecast traffic demand and growth patterns.	**Unit 2.0 Traffic Studies and Data Analysis.** 2.1 Traffic Volume Studies- Manual & automatic traffic counting methods (tally sheets, pneumatic tubes, video, inductive loops), Vehicle classification & traffic composition, Peak Hour Factor (PHF), daily/seasonal variations, Volume expansion factors & AADT calculation 2.2 Speed Studies & Analysis- Spot speed methods: enoscope, radar, pneumatic detectors, Time-mean vs space-mean speed; speed distribution & percentiles, Journey speed: floating car method, Delay studies: license plate & probe vehicle methods, Speed-flow relationships, congestion, & statistical analysis 2.3 Traffic forecasting using various models.	**CO2**
TSO 3a. Design intersections and traffic control systems. *TSO 3b.* Optimize signal timing and coordination.	**Unit 3.0 Intersection Design and Traffic Control** 3.1 Intersection Design. 3.2 Traffic control system and signal optimization.	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 3c. Analyze roundabouts and interchange designs.	3.3 Analysis of roundabouts and interchange designs.	
TSO 4a. Conduct traffic safety analysis and accident investigation. *TSO 4b.* Develop safety countermeasures and evaluation methods. *TSO 4c.* Apply road safety audit procedures.	**Unit 4.0 Traffic Safety Analysis and Management** 4.1 Accident & Conflict Analysis- Accident data collection, classification, and statistical analysis, Prediction models, black spot identification, and economic evaluation, Conflict types and analysis (TTC, PET, video-based methods), Safety performance functions and automated conflict detection. 4.2 Road Safety Audit & Inspection- Audit stages, team roles, common issues, and reporting, Road safety inspections, management systems, and global best practices 4.3 Safety Measures & Vulnerable Users- Engineering, enforcement, and education-based countermeasures, Safety for pedestrians, cyclists, motorcyclists, school zones, and senior citizens.	**CO4**
TSO 5a. Implement urban traffic management strategies . *TSO 5b.* Design traffic calming and parking management systems. *TSO 5c.* Integrate public transportation and demand management.	**Unit -5.0: Urban Traffic Management** 5.1 Urban Traffic Strategies- Traffic control principles, area/corridor management, Congestion pricing, park-and-ride, HOV lanes, Freight and event traffic management, performance evaluation. 5.2 Traffic Calming & Neighborhood Management- Speed/volume reduction measures (humps, chicanes, diverters), Neighborhood plans, shared spaces, complete streets, Calming arterial roads, effectiveness, legal aspects. 5.3 Parking & Public Transport Integration- Parking demand/supply, on/off-street management, pricing, Smart systems: meters, apps, shared parking, sustainability, Public transport priority, BRT, intermodal integration, Smart ticketing, real-time info, performance evaluation.	**CO5**
TSO 6a. Apply ITS technologies and traffic management systems. *TSO 6b.* Utilize traffic simulation software for analysis. *TSO 6c.* Analyze emerging technologies and sustainable practices.	**Unit -6.0: Intelligent Transport Systems** 6.1 Introduction to ITS- ITS architecture, components, standards, protocols, Benefits, challenges, deployment strategies, Global practices, PPP models, integration & trends. 6.2 Advanced Traffic Management- Traffic	**CO6**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	Management Centers, adaptive signals (SCATS, SCOOT), Detection tech, variable message signs, incident management, Data collection, system performance, evaluation. 6.3 Traffic Simulation & Modeling- Simulation types: micro, meso, macro, Tools: VISSIM, etc; calibration, validation, Input/output analysis, optimization, real-time & CAV simulation.	

J) Suggested Laboratory Experiences: (Not Applicable)

K) Suggested Research-Based Problems

i. Development of an adaptive traffic signal control system for urban corridors.
ii. Traffic safety analysis and countermeasure design for accident-prone locations.
iii. Optimization of the parking management system for the central business district.
iv. Integration of public transportation with traffic management systems.
v. Impact assessment of traffic calming measures on neighborhood traffic.
vi. Design of an intelligent transportation system for smart city development.
vii. Evaluation of roundabout performance versus signalized intersection.
viii. Development of a traffic management plan for special events and emergencies.

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):

- Traffic impact assessment report for a proposed development project.
- Design of traffic signal timing plan for a corridor with multiple intersections.
- Traffic safety audit report for an existing roadway segment.
- Development of a traffic management plan for urban area congestion mitigation.
- Analysis and comparison of different intersection control alternatives.
- Parking demand and supply analysis with management recommendations.

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 Traffic Flow Theory and Characteristics	06
CO2	Unit 2.0 Traffic Studies and Data Analysis	06
CO3	Unit 3.0 Intersection Design and Traffic Control	07
CO4	Unit 4.0 Traffic Safety Analysis and Management	07
CO5	Unit -5.0: Urban Traffic Management	07
CO6	Unit -6.0: Intelligent Transport Systems	07
Total		**40**

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.	Traffic Engineering and Transport Planning	Dr. L.R. Kadiyali	3rd Edition, Khanna Publishers, 2011 ISBN-13: 9788174092205
2.	Highway Engineering	S.K. Khanna, C.E.G. Justo, A. Veeraragavan	Nem Chand Publishers, ISBN: 978-81-85240-51-5
3.	Traffic Engineering	Dr. S.P. Bindra, Dr. S.S. Jain	2nd Edition, Khanna Publishers ISBN: 9788174091062
4.	Traffic Engineering	Roger P. Roess, Elena S. Prassas, William R. McShane	Pearson, ISBN: 978-0-13-142471-1
5.	Urban Transportation Planning	Dr. Kumares C. Sinha, Dr. Samuel Labi	Indian Edition, Wiley India, ISBN: 9780470049211

b) Online Educational Resources (OER):

1) NPTEL – Traffic Engineering (IIT Kharagpur)
https://archive.nptel.ac.in/courses/105/105/105105215/

2) MIT OCW – Transportation Flow Systems
https://ocw.mit.edu/courses/1-225j-transportation-flow-systems-fall-2002/

3) NPTEL – Traffic Engineering & Management (IIT Bombay)
https://archive.nptel.ac.in/courses/105/101/105101008/

4) NPTEL – Traffic Engineering (IIT Kharagpur)
https://archive.nptel.ac.in/courses/105/105/105105215/

5) NPTEL – Urban Transport Systems Planning (IIT Kharagpur)
https://archive.nptel.ac.in/courses/105/105/105105208/

6) NPTEL – Traffic Engineering & Management (IIT Bombay)
https://archive.nptel.ac.in/courses/105/101/105101008/

7) NPTEL – Urban Transportation Planning (IIT Madras)
https://nptel.ac.in/courses/105106058

8) NPTEL – Traffic Engineering (ITS module)
https://archive.nptel.ac.in/courses/105/105/105105215/

Q) Course Curriculum Development Team

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A)	**Course Title:** Geometric Design of Transportation Systems	Deemed to be University under Distinct Category
B)	**Course Code:** TEM06	
C)	**Pre-requisite (s):** Transportation Engineering/ Highway Engineering/ Engineering drawing & Graphics	

D) **Rationale:** Geometric design forms the foundation of all transportation infrastructure development. This course provides a comprehensive understanding of design principles for various transport modes, including highways, railways, and urban transit systems. Students will learn to apply modern design standards while considering safety, efficiency, environmental impact, and economic factors. The course emphasizes practical application through software tools and real-world case studies, preparing learners to handle complex geometric design challenges in contemporary transportation projects.

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
TEM06.CO1	Analyze geometric design principles for highway alignments, considering topography, traffic characteristics, and safety requirements.
TEM06.CO2	Evaluate railway track geometry, including horizontal and vertical alignments for different operational speeds.
TEM06.CO3	Apply advanced software tools for geometric design analysis, visualization, and optimization of transportation facilities.
TEM06.CO4	Integrate sustainable design practices and safety considerations in geometric design solutions for multi-modal transportation systems.

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
TEM06.CO1	3	2	3
TEM06.CO2	3	2	3
TEM06.CO3	2	3	3
TEM06.CO4	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)	
TEM06	PCC	Geometric Design of Transportation Systems	30	15	-	45	90	03	30	40	50	-	-	-	120

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 philosophy and human factors in transportation design. *TSO 1b.* Apply appropriate design standards for different transportation modes. *TSO 1c.* Evaluate the design constraints and control for a given site condition. *TSO 1d.* Analyze traffic characteristics for a given traffic condition.	**Unit 1.0 Fundamentals of Geometric Design** 1.1 Design Philosophy and Principles: Historical evolution of geometric design, design objectives, relationship between geometric design and traffic operations, human factors in design, design vehicle characteristics, and their impact on geometric elements. 1.2 Design Standards and Guidelines: IRC standards for highways, ICAO standards for airports, Indian Railway standards, comparative study of international design practices, design speed concepts, and selection criteria.. 1.3 Design Controls and Constraints: Topographical constraints, environmental considerations, economic factors, right-of-way limitations, existing infrastructure constraints, and regulatory and legal requirements. 1.4 Traffic Characteristics: Design hourly volume, vehicle composition, directional distribution, growth factors, level of service concepts, capacity considerations in geometric design.	**CO1**
TSO 2a. Design horizontal alignment elements for a given highway section. *TSO 2b.* Design vertical alignment for a given highway section considering safety and comfort. *TSO 2c.* Determine appropriate cross-sectional element for a given highway section. *TSO 2d.* Design basic intersection layouts for a given highway section.	**Unit 2.0 Highway Geometric Design** 2.1 Horizontal Alignment Design: Straight sections and their limitations, circular curves - minimum radius, super elevation design, transition curves - clothoid spirals, compound and reverse curves, design of intersections at grade, horizontal sight distance requirements, design for different terrain conditions. 2.2 Vertical Alignment Design: Gradients and their limitations, vertical curves - crest and sag curves, design for comfort and safety, sight distance on vertical curves, coordination of horizontal and vertical alignments, drainage considerations in vertical alignment. 2.3 Cross-sectional Elements: Carriageway width determination, shoulder design, median design, side slopes and their stability, roadside design for safety, clear zone concepts, barrier design and placement. 2.4 Intersection Design: At-grade intersection design principles, channelization, roundabout design, grade-separated intersections,	**CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	interchange design basics, and pedestrian and bicycle facilities integration.	
TSO 3a. Analyze track geometry fundamentals. *TSO 3b.* Design horizontal alignment for railways. *TSO 3c.* Design vertical alignment for different operational requirements. *TSO 3d.* Design special track features and facilities.	**Unit 3.0 Railway Geometric Design** 3.1 Track Geometry Fundamentals: Gauge considerations, rail sections and their selection, sleeper types and spacing, ballast design, track modulus concepts, wheel-rail interaction principles. 3.2 Horizontal Alignment: Minimum curve radius for different speeds, superelevation and speed relationships, transition curves in railway design, compound curves application, design for tilting trains. 3.3 Vertical Alignment: Ruling gradient determination, momentum gradient, vertical curve design, sight distance requirements for railways, design for different traction systems. 3.4 Special Track Features: Turnouts and crossovers design, railway yards layout, platform design standards, level crossing design, design for high-speed rail corridors, maintenance facility design requirements.	**CO3**
TSO 4a. Apply suitable computer-aided design tools for given project effectively. *TSO 4b.* Conduct safety analysis and risk assessment for a given site condition. *TSO 4c.* Explain emerging technologies in transportation design. *TSO 4d.* Integrate sustainable practices in geometric design for a given structure.	**Unit -4.0 Advanced Topics and Integrated Design** 4.1 Computer-Aided Design Applications: Introduction to highway design software (AutoCAD Civil 3D), 3D modeling and visualization techniques, design optimization using software tools. 4.2 Sustainable Design Practices: Green infrastructure integration, stormwater management in geometric design, wildlife crossing design, noise barrier integration, landscape design considerations, life cycle cost analysis in design decisions. 4.3 Emerging Technologies: Autonomous vehicle considerations in geometric design, smart infrastructure integration, BIM applications in transportation design, GIS integration in design process, drone applications in surveying and design. 4.4 Safety and Risk Assessment: Road safety audit procedures, geometric design safety analysis, accident prediction models, vulnerable road user considerations, design for all-weather operations.	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	4.5 Case Studies: Analysis of successful transportation projects, design challenges and solutions, lessons learned from failed projects, Indian and international best practices, innovation in geometric design.	

J) Suggested Laboratory Experiences: (Not Applicable)

K) Suggested Research-Based Problems

i. **Optimization of Highway Alignment**: Develop algorithms for optimizing highway alignment considering multiple constraints, including cost, environmental impact, and safety.

ii. **Climate Change Impact on Geometric Design**: Investigate how changing weather patterns affect geometric design standards and propose adaptive design solutions.

iii. **Autonomous Vehicle Infrastructure Requirements**: Research geometric design modifications needed for autonomous vehicle operations.

iv. **Sustainable Airport Design**: Develop a framework for integrating sustainability principles in airport geometric design.

v. **High-Speed Rail Geometric Design**: Study geometric design requirements for high-speed rail corridors in Indian conditions.

vi. **Rural Road Geometric Design Standards**: Develop context-sensitive geometric design standards for rural roads in India.

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):

- Highway Design Project: Complete geometric design of a 5-km highway section, including horizontal alignment, vertical alignment, and cross-sections.
- Railway Alignment Design: Design horizontal and vertical alignment for a 10-km railway section through hilly terrain.
- Software Application Assignment: Complete design projects using professional software and submit detailed reports with drawings.
- Case Study Analysis: Analyze and present case studies of successful transportation geometric design projects.
- Design Standard Comparison: Compare geometric design standards of India with international practices and prepare a technical report.

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: Fundamentals of Geometric Design.	08
CO2	Unit 2.0: Highway Geometric Design.	12
CO3	Unit 3.0: Railway Geometric Design.	09
CO4	Unit 4.0: Advanced Topics and Integrated Design.	11
Total		**40**

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.	Geometric Design of Roads Handbook	Lamm, Psarianos, and Mailaender	CRC Press, ISBN: 978 0849308598
2.	Highway Engineering	Khanna S.K. and Justo C.E.G.	Nem Chand & Bros, ISBN: 978-8122415049
3.	Railway Track Engineering	Profillidis V.A	Ashgate Publishing, ISBN: 978-0754650249
4.	Geometric Design of Highways	Mannering, Washburn, and Kilareski	John Wiley & Sons, ISBN: 978-0470170861

b) Online Educational Resources (OER):

1) Topics: Stress-strain behavior, Cam-Clay, critical state
https://archive.nptel.ac.in/courses/105/103/105103207/

2) Advanced Soil Mechanics by Prof. B.V.S. Viswanadham (IIT Bombay)
https://www.youtube.com/playlist?list=PLwdnzlV3ogoWF5fz8UH4TYtEWH9tqZkfY

3) Pile foundations, caissons, group effects
https://archive.nptel.ac.in/courses/105/107/105107158/

4) Deep Foundations by NPTEL
https://www.youtube.com/playlist?list=PLD4FD2A4E0D6F5F95

5) Vibro-compaction, grouting, geosynthetics
https://archive.nptel.ac.in/courses/105/108/105108075/

6) Ground Improvement Techniques (IIT Madras)
https://www.youtube.com/playlist?list=PLbMVogVj5nJRb_yA6oMKfoT89hyUcuHIA

7) Slope Stability by Dr. G.V. Ramana
https://www.youtube.com/playlist?list=PL5F88D7F7A7D3A1B5

8) Liquefaction, seismic design, site response
https://archive.nptel.ac.in/courses/105/101/105101134/

9) Geotechnical Earthquake Engineering (IIT Bombay)
https://www.youtube.com/playlist?list=PLbMVogVj5nJRNzx4KtSTVj7qr9OxwY3IF

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A)	**Course Title:** Railway Engineering	Deemed to be University under Distinct Category
B)	**Course Code:** TEM07	
C)	**Pre-requisite Course (s):** Transportation Engineering/ Strength of Materials/ Engineering Mechanics.	

D) **Rationale:** Railway systems form the backbone of mass transportation in India, handling over 8 billion passenger journeys annually. This course provides essential knowledge of railway engineering principles, design methodologies, and modern technologies. Students will gain a comprehensive understanding of track engineering, rolling stock, signaling systems, and operational management. The curriculum emphasizes practical applications relevant to Indian Railways while incorporating global best practices and emerging technologies like high-speed rail and metro systems.

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
TEM07.CO1	Design permanent way structures for different operational requirements.
TEM07.CO2	Evaluate rolling stock characteristics and their interaction with track infrastructure for safe and efficient operations.
TEM07.CO3	Apply railway signaling and communication systems for train control and operational safety.
TEM07.CO4	Integrate modern technologies and sustainable practices in railway engineering solutions.

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
TEM07.CO1	3	2	3
TEM07.CO2	3	2	3
TEM07.CO3	3	2	3
TEM07.CO4	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)	
TEM07	PEC	Railway Engineering	30	15	-	45	90	03	30	40	50	-	-	-	120

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 track structure components and their functions. *TSO 1b.* Design rail sections and analyze rail stresses. *TSO 1c.* Select appropriate sleeper types and fastening systems.	**Unit 1.0 Railway Track Engineering and Permanent Way** 1.1 Track Structure Fundamentals: Railway gauge systems and their selection criteria, standard gauge vs broad gauge considerations, track components hierarchy - rails, sleepers, ballast, formation, subgrade characteristics and their engineering properties, load transfer mechanism in railway tracks, dynamic behavior under moving loads. 1.2 Rail Engineering: Rail sections and their evolution, rail steel specifications and manufacturing processes, rail joints and welding techniques, continuous welded rail (CWR) technology, thermal stresses in rails, rail defects identification and prevention, rail grinding and maintenance practices. 1.3 Sleeper Design and Technology: Timber sleepers - types, treatment, and limitations, concrete sleepers - prestressed and reinforced designs, steel sleepers applications, composite sleepers and modern alternatives, sleeper spacing calculations, sleeper-ballast interaction, fastening systems - elastic and rigid types.	**CO1, CO4**
TSO 2a. Apply track geometry standards and design parameters. *TSO 2b.* Plan track maintenance strategies and operations. *TSO 2c.* Evaluate modern track technologies and their applications.	**Unit 2.0 Track Geometry and Maintenance** 2.1 Track Geometry Standards: Horizontal alignment parameters, vertical alignment design, Cant and Cant deficiency calculations, transition curves in railways, speed restrictions and geometry relationships, tolerance limits for track parameters, geometric quality assessment methods. 2.2 Track Maintenance Systems: Preventive vs corrective maintenance strategies, tamping operations and equipment, ballast cleaning and renewal processes, rail replacement techniques, track recording cars and geometry measurement, condition monitoring systems, predictive maintenance using AI and IoT. 2.3 Modern Track Technologies: Slab track systems for high-speed railways, ballastless track construction, track monitoring sensors and smart infrastructure, automated track inspection systems, machine-assisted maintenance techniques, and sustainability in track maintenance practices.	**CO2, CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 3a. Design basic signaling systems and interlocking. *TSO 3b.* Apply modern signaling technologies for train control. *TSO 3c.* Integrate communication systems in railway operations.	**Unit 3.0 Railway Signaling and Communication Systems** 3.1 Signaling Fundamentals: Railway signaling principles and philosophy, signal types and their meanings, block systems - absolute block, automatic block, tokenless block, interlocking systems and safety principles, fail-safe design concepts, human factors in signaling. 3.2 Modern Signaling Technologies: Electronic interlocking systems, computer-based signaling, automatic train protection (ATP) systems, automatic train control (ATC), communication-based train control (CBTC), European train control system (ETCS) principles, positive train control systems.. 3.3 Communication Systems: Railway telecommunications infrastructure, train radio systems, passenger information systems, CCTV and security systems, fiber optic networks in railways, satellite communication applications, emergency communication protocols, integration with national communication networks.	**CO3, CO4**

J) Suggested Laboratory Experiences: (Not Applicable)

K) Suggested Research-Based Problems

i. High-Speed Rail Track Design: Develop track design standards for 300+ km/h operations in Indian conditions.
ii. Predictive Maintenance Systems: Create AI-based predictive maintenance models for railway track components.
iii. Energy Efficient Railway Operations: Optimize train operations for minimum energy consumption using renewable sources.
iv. Smart Railway Infrastructure: Design IoT-based monitoring systems for railway infrastructure health assessment.
v. Sustainable Railway Materials: Research alternative materials for sleepers and ballast with reduced environmental impact..
vi. Railway Safety Enhancement: Develop advanced safety systems integrating multiple technologies for accident prevention.

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):

- Track Design Project: Complete design of railway track for a 20 km section, including all components.
- Rolling Stock Analysis: Comparative analysis of different locomotive types and their performance characteristics.
- Signaling System Design: Design a complete signaling system for a railway junction with an interlocking diagram.
- Station Layout Design: Design passenger station layout with all facilities and passenger flow analysis.
- Railway Electrification Project: Design an electrification system for an existing railway section.
- Case Study Presentation: Analysis of modern railway projects in India or internationally.

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 Railway Track Engineering and Permanent Way.	12
CO2	Unit 2.0 Track Geometry and Maintenance.	14
CO3, CO4	Unit 3.0 Railway Signaling and Communication Systems.	14
Total		**40**

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.	Railway Track Engineering	Lichtberger B.	Eurail Press, ISBN: 978-3777103518
2.	Railway Engineering	Saxena S.C. and Arora S.P.	Dhanpat Rai Publications, ISBN: 978 8177002201

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
3.	Track Compendium	Esveld C	MRT Productions, ISBN: 978 9080032248
4.	Railway Track Engineering	Profillidis V.A	Ashgate Publishing, ISBN: 978 0754650249
5.	Railway Signalling and Interlocking	Kinde E.E	Oxford University Press, ISBN: 978 0198562436

b) Online Educational Resources (OER):

1) NPTEL – Railway Engineering (IIT Roorkee)-Railway Track Engineering and Permanent Way
https://onlinecourses.nptel.ac.in/noc24_ce81/preview
2) Introduction to Railway Engineering - Railway Track Engineering and Permanent Way
https://www.youtube.com/watch?v=37WMS483T7Y
3) Railway Engineering (IIT Roorkee)-Track Geometry and Maintenance
https://onlinecourses.nptel.ac.in/noc24_ce81/preview
4) Railway Engineering (IIT Roorkee)-Rolling Stock and Train Dynamics
https://onlinecourses.nptel.ac.in/noc24_ce81/preview
5) Lecture on Railway Signaling-Railway Signaling and Communication Systems
https://www.youtube.com/watch?v=8iqgNuSujy8

Q) Course Curriculum Development Team

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A)	**Course Title:** Airport Engineering	Deemed to be University under Distinct Category
B)	**Course Code:** TEM08	
C)	**Pre-requisite Course (s):** Transportation Engineering/ Soil Mechanics and Foundation Engineering/Concrete Technology.	

D) **Rationale:** Airport engineering is a specialized field requiring a comprehensive understanding of aviation infrastructure development and management. With India's rapid aviation growth and government initiatives like the UDAN scheme, there is increasing demand for qualified airport engineers. This course provides essential knowledge of airport planning, design, construction, and operations, covering both technical and regulatory aspects. Students will gain expertise in runway design, terminal planning, air traffic management systems, and safety protocols, preparing them for careers in airport development authorities, consulting firms, and aviation regulatory bodies.

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
TEM08.CO1	Apply airport planning principles for site selection of different categories of airports.
TEM08.CO2	Design airport pavements considering aircraft loading, environmental conditions, and operational requirements.
TEM08.CO3	Design terminal building and passenger flow management systems for efficient airport operations.
TEM08.CO4	Apply airport safety standards and air traffic management principles in airport design and operations.
TEM08.CO5	Integrate sustainable practices and modern technologies in airport engineering solutions.

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
TEM08.CO1	3	2	3
TEM08.CO2	3	2	3
TEM08.CO3	2	3	3
TEM08.CO4	3	2	3
TEM08.CO5	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)	
TEM08	PEC	Airport Engineering	30	15	-	45	90	03	30	40	50	-	-	-	120

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 aviation industry trends and airport roles in the transportation system. *TSO 1b.* Classify different types of airport classification systems and planning principles. *TSO 1c.* Evaluate site selection criteria and master planning processes. *TSO 1d.* Design a basic airport layout considering operational requirements.	**Unit 1.0 Airport Planning and Classification** 1.1 Aviation Industry Overview: Global and Indian aviation growth trends, role of airports in economic development, airport ownership models, public-private partnerships in airport development, regulatory framework including DGCA, AAI, and international organizations like ICAO and IATA. 1.2 Airport Classification Systems: ICAO airport classification based on runway length and aircraft types, domestic and international airport categories, hub and spoke vs point-to-point operations, cargo vs passenger airports, general aviation airports, and military airport considerations. 1.3 Site Selection and Planning: Site selection criteria include topography, meteorology, accessibility, environmental impact, land acquisition considerations, master planning process, airport catchment area analysis, demand forecasting methodologies, and capacity planning concepts. 1.4 Airport Layout Planning: Overall airport configuration, terminal area planning, airside and landside integration, ground transportation access, parking facilities planning, cargo area planning, maintenance facilities, fuel storage areas, emergency services locations.	**CO1, CO5**
TSO 2a. Design runway geometry considering aircraft operations and safety. *TSO 2b.* Calculate runway length requirements for different aircraft types. *TSO 2c.* Apply airfield marking and lighting standards.	**Unit 2.0 Runway and Taxiway Design** 2.1 Runway Design Fundamentals: Runway orientation based on wind analysis, crosswind components, usability factor calculations, runway length determination for different aircraft types, obstacle clearance requirements, approach and departure path design, runway capacity analysis. 2.2 Runway Geometric Design: Runway width determination, shoulder design, runway end safety areas (RESA), runway strip requirements, blast pad design, stopway and clearway concepts, runway intersection design, parallel runway separation criteria. 2.3 Airfield Marking and Lighting: Runway and	**CO2, CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	taxiway marking standards, precision approach path indicators (PAPI), approach lighting systems, runway edge lighting, taxiway guidance systems, airfield ground lighting maintenance, LED technology applications. 2.4 Drainage Systems: Airfield drainage design principles, surface water management, subsurface drainage, runway grooving for wet weather operations, hydroplaning prevention, drainage infrastructure integration with pavement design.	
TSO 3a. Analyze aircraft loading effects on pavement structures. *TSO 3b.* Design flexible pavements using standard methodologies. *TSO 3c.* Design rigid pavements for airport applications. *TSO 3d.* Evaluate pavement condition for planning maintenance strategies.	**Unit 3.0 Airport Pavement Design.** 3.1 Aircraft Loading and Pavement Response: Aircraft gear configurations, load distribution patterns, contact pressure analysis, pavement stress analysis, fatigue considerations, critical aircraft concept, equivalent single wheel loads, mixed traffic analysis. 3.2 Flexible Pavement Design: Layer composition in flexible pavements, material specifications for different layers, design methodologies including CBR method and mechanistic approaches, thickness design procedures, staged construction considerations, overlay design principles. 3.3 Rigid Pavement Design: Concrete pavement design principles, joint design and spacing, reinforcement requirements, concrete mix design for airport pavements, construction procedures, quality control measures, pavement texture requirements for aircraft operations. 3.4 Pavement Evaluation and Maintenance: Pavement condition assessment techniques, non-destructive testing methods, falling weight deflectometer applications, pavement management systems, preventive maintenance strategies, rehabilitation techniques, life cycle cost analysis.	**CO3, CO5**
TSO 4a. Analyze air traffic management systems and operations. *TSO 4b.* Apply safety and security principles in airport design. *TSO 4c.* Integrate sustainable practices in airport development.	**Unit 4.0: Airport Operations and Safety Aspects** 4.1 Air Traffic Management Systems: Airport traffic control systems, ground radar systems, communication systems, navigation aids, precision approach systems, automated dependent surveillance, NextGen and SESAR initiatives, unmanned traffic management	**CO4, CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	integration 4.2 Airport Safety and Security: Runway safety management, foreign object debris (FOD) control, bird strike hazard management, emergency response planning, aircraft rescue and fire-fighting (ARFF) services, security infrastructure design, screening technologies 4.3 Sustainable Airport Development: Green building certification for airports, renewable energy systems, carbon footprint reduction strategies, noise abatement procedures, waste management systems, water conservation measures, and sustainable pavement materials.	

J) Suggested Laboratory Experiences: (Not Applicable)

K) Suggested Research-Based Problems

i. Climate Resilient Airport Design: Develop design guidelines for airports considering climate change impacts and extreme weather events.
ii. Sustainable Airport Pavement Materials: Research alternative pavement materials using recycled content and bio-based materials.
iii. Drone Integration at Airports: Study infrastructure modifications required for safe drone operations at commercial airports.
iv. AI-based Terminal Flow Optimization: Develop artificial intelligence algorithms for optimizing passenger flow in terminal buildings.
v. Green Airport Energy Systems: Design renewable energy systems for airport self-sufficiency and carbon neutrality.
vi. Airport Noise Mitigation Strategies: Research innovative approaches for reducing airport noise impact on surrounding communities.

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):

- Airport Master Plan Project: Develop a comprehensive master plan for a regional airport, including layout, phasing, and capacity analysis.
- Runway Design Assignment: Complete detailed runway design, including length calculation, geometric design, and pavement design.
- Terminal Building Design: Design the terminal building layout with passenger flow analysis and capacity calculations.
- Pavement Management System: Develop pavement maintenance plan using condition assessment data and life cycle cost analysis.

- Case Study Analysis: Analyze successful airport development projects and present lessons learned.
- Sustainability Assessment: Evaluate and propose sustainability measures for an existing airport facility.

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, CO5	Unit 1.0: Airport Planning and Classification	8
CO2, CO5	Unit 2.0: Runway and Taxiway Design.	10
CO3, CO5	Unit 3.0: Airport Pavement Design.	10
CO4, CO5	Unit 4.0: Airport Operations and Safety Aspects.	12
Total		**40**

N) Suggested 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: (Not Applicable)

P) Suggested Learning Resources:

a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Airport Planning and Design	Horonjeff R., McKelvey F., Sproule W., and Young S.	McGraw-Hill Education, ISBN: 978-0071446419
2.	Introduction to Airport Engineering	Hsu C.I. and Chao C.C	ASCE Press, ISBN: 978-0784479018
3.	Airport Systems: Planning, Design and Management	Neufville R. and Odoni A.	McGraw-Hill, ISBN: 978-0071384438
4.	Airport Pavement Design and Evaluation	Haas R. and Hudson W.R	Krieger Publishing, ISBN: 978-0894644184
5.	Airport Engineering: Planning, Design and Development of 21st Century Airports	Kazda A. and Caves R.E	John Wiley & Sons, ISBN: 978-0470018125

b) Online Educational Resources (OER):

1) **Aviation Industry Overview**
https://www.icao.int/MID/Documents/2022/Airport%20Master%20Seminar/AMP%204%20-%20Aircraft%20and%20Airport%20Compatibility_updated.pdf
2) **Airport Layout Planning**
https://www.faa.gov/documentlibrary/media/advisory_circular/150-5300-13/150_5300_13_part1.pdf
3) **Runway Design Fundamentals**
https://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5300_13_part2.pdf
4) **Runway Geometric Design**
https://www.faa.gov/documentlibrary/media/advisory_circular/150-5300-13/150_5300_13_part1.pdf
5) **Taxiway System Design**
https://skybrary.aero/sites/default/files/bookshelf/3090.pdf
6) **Airfield Marking and Lighting**
https://www.faa.gov/air_traffic/publications/atpubs/aim_html/chap2_section_1.html
7) **Air Traffic Management Systems**
https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/air_traffic_services
8) **Airport Safety and Security**
https://www.faa.gov/airports/airport_safety

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A)	**Course Title:** Advanced Geo-Technical Engineering	Deemed to be University under Distinct Category
B)	**Course Code:** TEM09	
C)	**Pre-requisite Course (s):** Soil Engineering/ Soil Mechanics/ Engineering Geology	

D) **Rationale:** Transportation infrastructure requires robust foundation systems to withstand complex loading conditions. This course provides advanced knowledge in geotechnical engineering principles specifically applicable to transportation projects, including highways, railways, airports, and bridges. Students will develop expertise in advanced soil behavior analysis, deep foundation systems, ground improvement techniques, and slope stability analysis. The course emphasizes modern computational methods and innovative materials used in transportation geotechnics, preparing learners to handle challenging geotechnical problems in transportation engineering projects.

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
TEM09.CO1	Analyze complex soil behavior under dynamic and cyclic loading conditions relevant to transportation infrastructure.
TEM09.CO2	Design deep foundation systems for transportation structures using advanced analytical and numerical methods.
TEM09.CO3	Evaluate ground improvement techniques for transportation projects in challenging soil conditions.
TEM09.CO4	Apply slope stability analysis techniques and design stabilization measures for transportation corridors.
TEM09.CO5	Utilize advanced geotechnical software tools for analysis and design of transportation geotechnical systems.

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
TEM09.CO1	3	2	3
TEM09.CO2	3	3	3
TEM09.CO3	3	2	3
TEM09.CO4	3	2	3
TEM09.CO5	2	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)	
TEM09	PEC	Advanced Geo-Technical Engineering	30	15	30	15	90	03	30	30	20	-	30	10	120

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 advanced stress-strain relationships in soils. *TSO 1b.* Analyze the dynamic behavior of soils under cyclic loading. *TSO 1c.* Apply constitutive models for numerical analysis.	**Unit 1.0 Advanced Soil Mechanics and Constitutive Modeling** 1.1 Stress-Strain Behavior of Soils: Advanced concepts in effective stress principle, stress path analysis, critical state soil mechanics, modified Cam-Clay model, and hardening soil models. 1.2 Dynamic Soil Properties: Cyclic loading effects, liquefaction potential assessment, dynamic shear modulus and damping ratio determination, laboratory testing methods (cyclic triaxial, resonant column tests). 1.3 Unsaturated Soil Mechanics: Soil-water characteristic curves, shear strength of unsaturated soils, volume change behavior, suction measurement techniques. 1.4 Constitutive Models: Elastic-plastic models, hyperbolic models, Duncan-Chang model, implementation in finite element analysis.	**CO1**
TSO 2a. Design pile foundations using advanced methods. *TSO 2b.* Analyze pile group behavior and settlements. *TSO 2c.* Apply numerical modeling for foundation design.	**Unit 2.0 Deep Foundation Systems for Transportation Infrastructure** 2.1 Pile Foundation Analysis: Advanced pile capacity theories, negative skin friction, pile group effects, settlement analysis using load transfer methods, and pile-soil interaction modeling. 2.2 Drilled Shafts and Caissons: Design methodology for large diameter deep foundations, construction techniques, load testing and interpretation, LRFD approach. 2.3 Special Foundation Systems: Micro-piles for underpinning and retrofitting, helical piles, composite pile systems, foundation systems for high-speed rail. 2.4 Numerical Modeling: 3D finite element analysis of deep foundations, soil-structure interaction, and modeling of construction sequence effects.	**CO2**
TSO 3a. Select appropriate ground improvement methods for a given site condition. *TSO 3b.* Design ground improvement systems for a given site. *TSO 3c.* Apply innovative method for improvement of the ground.	**Unit 3.0 Ground Improvement Techniques** 3.1 Mechanical Stabilization: Deep mixing methods, jet grouting, compaction grouting, vibro-compaction, and vibro-replacement techniques. 3.2 Chemical Stabilization: Lime stabilization, cement stabilization, fly ash applications,	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	polymer and geopolymer stabilization methods. 3.3 Reinforcement Techniques: Geosynthetic reinforced soil systems, soil nailing, ground anchors, and mechanically stabilized earth walls. 3.4 Innovative Methods: Bio-engineering approaches, enzyme stabilization, recycled materials in ground improvement, and sustainable ground improvement practices.	
TSO 4a. Apply a suitable slope stability analysis method for a given site condition. *TSO 4b.* Design reinforced soil systems for a given site condition. *TSO 4c.* Develop landslide mitigation strategies for a given site condition.	**Unit 4.0 Slope Stability and Earth Retaining Structures** 4.1 Advanced Slope Stability Analysis: Limit equilibrium methods, Spencer's method, Morgenstern-Price method, finite element limit analysis, probabilistic slope stability analysis. 4.2 Reinforced Soil Structures: Design of geosynthetic reinforced slopes, soil nailing design, analysis of compound stability, seismic design considerations. 4.3 Earth Retaining Systems: Mechanically stabilized earth walls, reinforced soil walls, hybrid systems, performance monitoring, and instrumentation. 4.4 Landslide Mitigation: Risk assessment, early warning systems, remediation techniques, case studies from transportation corridors.	**CO4**
TSO 5a. Design a given retaining structure for applicable seismic condition. *TSO 5b.* Design pavement foundation for a given site condition. *TSO 5c.* Apply geosynthetic materials in transportation projects.	**Unit -5.0: Geotechnical Earthquake Engineering and Pavement Geotechnics** 5.1 Seismic Geotechnics: Ground response analysis, site characterization for seismic design, liquefaction assessment and mitigation, seismic design of retaining structures. 5.2 Pavement Foundation Design: Subgrade characterization, CBR and resilient modulus testing, pavement-subgrade interaction, design of pavement foundations on soft soils. 5.3 Geosynthetics in Transportation: Applications in pavements, railways, and airports, drainage systems, separation and filtration functions. 5.4 Quality Control and Monitoring: Field testing methods, instrumentation for long-term monitoring, performance evaluation of geotechnical systems.	**CO5**

J) Suggested Laboratory Experiences:

Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment Titles	Relevant CO Number (s)
LSO 1.1.	Conduct advanced soil testing procedures.	1.	Advanced Triaxial Testing: Consolidated undrained and drained tests, stress path analysis.	CO1
LSO 2.1.	Conduct advanced soil testing procedures.	2.	Cyclic Loading Tests: Cyclic triaxial tests for liquefaction assessment.	CO1
LSO 3.1.	Interpret load test results for foundation design.	3.	Pile Load Testing: Static and dynamic pile load tests, data interpretation.	CO2
LSO 4.1.	Evaluate ground improvement effectiveness.	4.	Ground Improvement Verification: Field density tests, plate load tests on improved ground.	CO3
LSO 5.1.	Analyze slope failure mechanisms.	5.	Slope Stability Modeling: Physical slope models, failure mechanism observation	CO4
LSO 6.1.	Assess geosynthetic material properties.	6.	Geosynthetic Testing: Tensile strength, pullout tests, interface friction tests.	CO5
LSO 7.1.	Characterize pavement foundation materials.	7.	Pavement Materials Testing: Resilient modulus, permanent deformation tests	CO5

K) Suggested Research-Based Problems

i. Liquefaction potential assessment for highway embankments in seismic zones.
ii. Performance evaluation of recycled materials in ground improvement applications.
iii. Development of sustainable foundation systems for transportation infrastructure.
iv. Optimization of geosynthetic reinforcement in steep slopes for mountain highways.
v. Long-term settlement prediction of transportation structures on soft clays.
vi. Bio-engineering solutions for slope stabilization in transportation corridors.
vii. Performance-based design of deep foundations under seismic loading.
viii. Smart monitoring systems for transportation geotechnical infrastructure.

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):

- **Case Study Analysis:** Detailed study of a major transportation geotechnical failure and proposed solutions.
- **Design Project:** Complete design of foundation system for a highway bridge including site investigation, analysis, and design calculations.
- **Numerical Modeling Assignment:** 3D finite element analysis of a complex geotechnical problem using commercial software.
- **Literature Review:** Comprehensive review on emerging trends in transportation geotechnics.
- **Laboratory Report:** Detailed analysis of laboratory test results with engineering interpretation.

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: Advanced Soil Mechanics and Constitutive Modeling.	05
CO2	Unit 2.0: Deep Foundation Systems for Transportation Infrastructure.	05
CO3	Unit 3.0: Ground Improvement Techniques.	06
CO4	Unit 4.0: Slope Stability and Earth Retaining Structures.	07
CO5	Unit 5.0: Geotechnical Earthquake Engineering and Pavement Geotechnics.	07
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.	Direct shear testing machine with large specimens	Tests on cohesionless soils (e.g., sands)	All
2.	Consolidation testing equipment	Incremental Loading, Dial Gauge Measurement, and Permeability Analysis	All
3.	Geosynthetic testing equipment	Tensile Strength, Creep Testing, and Puncture Resistance	All
4.	Automated triaxial testing system	cyclic loading capability, Data Acquisition	All

P) Suggested Learning Resources:

a) Books

S. No.	Titles	Author(s)	Publisher and Edition withISBN
1.	Advanced Soil Mechanics	Braja M. Das	CRC Press, ISBN: 978-1498741392
2.	Soil Mechanics and Foundation Engineering	K.R. Arora	Standard Publishers, ISBN: 978-8180391183

S. No.	Titles	Author(s)	Publisher and Edition withISBN
3.	Earthquake Geotechnical Engineering	Kenji Ishihara	Springer, ISBN: 978-9401039284
4.	Principles of Foundation Engineering	Braja M. Das	Cengage Learning, ISBN: 978-1337705028
5.	Geotechnical Engineering: Principles and Practices	Donald P. Coduto	Pearson, ISBN: 978-0132368681

b) Online Educational Resources (OER):

1) **ASCE Geotechnical Special Publications:**
https://ascelibrary.org/
2) **International Society for Soil Mechanics:**
https://www.issmge.org/
3) **Introduction to Geotechnical Engineering" - IIT Kharagpur (NPTEL):**
https://nptel.ac.in/courses/105105104
4) **Advanced Foundation Engineering" - IIT Roorkee (NPTEL):**
https://nptel.ac.in/courses/105107159
5) **Geotechnical Engineering Lectures by IIT Faculty:**
https://www.youtube.com/c/NPTEL-NOC-IITM
6) **Geotechnical Case Studies:**
https://www.youtube.com/c/GeotechnicalEngineeringTV
7) **Dynamic Soil Properties & Liquefaction Assessment**
https://www.fema.gov/sites/default/files/documents/fema-550-tech-manual-liquefaction.pdf
8) **Geosynthetic Reinforced Soil Systems (FHWA Tech Brief)**
https://www.fhwa.dot.gov/engineering/geotech/pubs/hif13007.pdf
9) **Earth Retaining Systems and Instrumentation**
https://www.nrcresearchpress.com/doi/pdf/10.1139/t04-089
10) **Pavement Subgrade Characterization and Design**
https://www.fhwa.dot.gov/pavement/geotech/pubs/
11) **Geosynthetics in Pavements and Transportation Infrastructure (GSI Brochure)**
https://www.geosynthetic-institute.org/publications/
12) **Field Testing and Monitoring in Geotechnical Engineering**
https://www.astm.org/Standards/D4566.htm

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A)	**Course Title:** Intelligent Transport Systems	Deemed to be University under Distinct Category
B)	**Course Code:** TEM10	
C)	**Pre-requisite Course (s):** Transportation Engineering	

D) **Rationale:** The rapid urbanization and increasing vehicular population in India demand sophisticated transportation solutions. Intelligent Transport Systems (ITS) represent the convergence of information technology, communications, and transportation engineering to create efficient, safe, and sustainable mobility solutions. This course introduces students to modern ITS technologies, including traffic management systems, vehicle-to-infrastructure communication, smart traffic signals, and automated transportation systems. Students will gain expertise in planning, designing, and implementing ITS solutions that address contemporary transportation challenges in Indian cities while considering global best practices and emerging technologies.

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
TEM10.CO1	Analyze various ITS architectures and technologies for urban transportation systems.
TEM10.CO2	Design traffic management and control systems using intelligent technologies.
TEM10.CO3	Apply communication technologies and data analytics in transportation engineering applications.
TEM10.CO4	Develop solutions for connected and autonomous vehicle integration in existing transportation infrastructure.

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
TEM10.CO1	2	1	3
TEM10.CO2	3	2	3
TEM10.CO3	3	2	2
TEM10.CO4	2	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)						
			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)	
TEM10	PEC	Intelligent Transport Systems	30	15	15	30	90	03	30	30	30	-	20	10	120

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. Identify appropriate ITS technologies for the transportation system. *TSO 1b.* Explain ITS benefits and its challenges.	**Unit 1.0 Introduction to Intelligent Transport Systems** 1.1 Fundamentals of ITS, Evolution of Intelligent Transport Systems, ITS architecture and system components, Global ITS standards and frameworks (ISO, IEEE, ETSI), Indian ITS initiatives and policy framework. 1.2 ITS Technologies Overview, Sensing technologies: loop detectors, cameras, radar, lidar, Communication technologies: DSRC, cellular, Wi-Fi, Bluetooth, Processing and computing platforms, Human-machine interfaces and user applications. 1.3 ITS Benefits and Challenges, Safety improvements and accident reduction, Traffic efficiency and congestion mitigation, Environmental impact and sustainability, Economic benefits and cost-benefit analysis, Implementation challenges in developing countries.	**CO1**
TSO 2a. Design traffic management systems and control strategies for a given traffic conditions. *TSO 2b.* Apply a traffic monitoring and surveillance system for a given set of traffic conditions.	**Unit 2.0 Traffic Management and Control Systems** 2.1 Advanced Traffic Signal Control, Adaptive signal control systems (SCATS, SCOOT), Traffic signal optimization algorithms, Coordinated signal control for arterials and networks, Priority systems for public transport and emergency vehicles. 2.2 Traffic Monitoring and Surveillance, Video detection and image processing techniques, Automatic incident detection systems, Traffic parameter estimation and data fusion, Real-time traffic information systems.	**CO2**
TSO 3a. Implement communication protocols and data exchange mechanisms.	**Unit 3.0 Communication Systems in Transportation** 3.1 Vehicle-to-Everything (V2X) Communication, Vehicle-to-Vehicle (V2V) communication protocols, Vehicle-to-Infrastructure (V2I) systems, Vehicle-to-Pedestrian (V2P) and Vehicle-to-Network (V2N), 5G and beyond for transportation applications. 3.2 Data Communication and Networking, Wireless communication protocols for ITS, Network	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
	architecture and topology design, Quality of Service (QoS) requirements, Cybersecurity in transportation networks. 3.3 Information Dissemination System, Dynamic message signs and variable message display, In-vehicle information system, Mobile applications and traveler information, Social media integration and crowd-sourcing.	
TSO 4a. Analyze connected and autonomous vehicle integration challenges.	**Unit 4.0 Connected and Autonomous Vehicles** 4.1 Connected Vehicle Technologies, On-board units and roadside equipment, Connected vehicle applications and use cases, Data collection and processing in connected vehicles, Privacy and security considerations. 4.2 Autonomous Vehicle Systems, Levels of vehicle automation (SAE J3016), Sensor fusion and perception systems, Path planning and decision-making algorithms, Human-machine interaction in automated vehicles. 4.3 Infrastructure Requirements, Smart infrastructure for autonomous vehicles, Digital mapping and high-definition maps, Dedicated lanes and infrastructure modifications, Mixed traffic scenarios and transition strategies.	**CO4**

J) Suggested Laboratory Experiences:

Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment Titles	Relevant CO Number (s)
LSO 1.1. Design and simulate basic ITS components.	1.	ITS Architecture Design and Simulation	CO1, CO2
LSO 2.1. Optimize traffic signal control systems.	2.	Traffic Signal Optimization	CO2
LSO 3.1. Implement and evaluate communication protocols.	3.	V2X Communication Simulation	CO3
LSO 4.1. Evaluate ITS implementation strategies.	4.	ITS Deployment Case Studies	CO4

K) Suggested Research-Based Problems

i. **Smart Traffic Signal Optimization for Indian Cities:** Develop adaptive signal control algorithms considering mixed traffic conditions, non-lane based traffic, and pedestrian behavior typical in Indian urban areas.

ii. **Connected Vehicle Implementation Strategy:** Design a phased implementation plan for connected vehicle technology in a tier-2 Indian city, considering infrastructure limitations and cost constraints.

iii. **Sustainable ITS Solutions:** Investigate the environmental impact of ITS implementation and propose green technologies for reducing the carbon footprint in transportation systems.

iv. **Public Transport Integration:** Design intelligent systems for integrating various public transport modes (buses, metro, auto-rickshaws) in Indian cities using IoT and mobile technologies.

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):

- **Literature Review:** Comprehensive review of recent ITS implementations in developing countries with a focus on lessons learned and best practices**.**
- **Case Study Analysis:** Detailed analysis of a successful ITS project including technical specifications, implementation challenges, and performance evaluation.
- **System Design Project:** Design an integrated ITS solution for a specific transportation problem in Bhopal city, including technical specifications and an implementation plan.
- **Simulation Study:** Conduct a traffic simulation study comparing conventional vs. intelligent transportation systems for a selected corridor.
- **Technology Assessment**: Evaluate emerging ITS technologies and their potential application in the Indian transportation context**.**

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: Introduction to Intelligent Transport Systems.	05
CO2	Unit 2.0: Traffic Management and Control Systems.	07
CO3	Unit 3.0: Communication Systems in Transportation.	09
CO4	Unit 4.0: Connected and Autonomous Vehicles.	09
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.	High-Performance Computing Workstations	Intel i7/AMD Ryzen processors, 16GB+ RAM, dedicated graphics cards & Above	All
2.	Network Infrastructure	High-speed internet connectivity for real-time data access and cloud computing	All
3.	MATLAB	Simulink for algorithm development	All
4.	GIS software	ArcGIS/QGIS	All

P) Suggested Learning Resources:

a) Books

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Intelligent Transport Systems: Technologies and Applications	Ghulam Md Ashraf, Suhang Song, and Nasser A	John Wiley & Sons, ISBN: 978-1119297505
2.	ITS Handbook: Recommendations from the World Road Association (PIARC)	World Road Association	Artech House Publishers, ISBN: 978-1630810801
3.	Connected Vehicles: Intelligent Transportation Systems	Ozan K. Tonguz and Wenshuang Liang	Springer, ISBN: 978-3319518893
4.	Traffic Engineering Handbook	Institute of Transportation Engineers (ITE)	John Wiley & Sons, ISBN: 978-1118762295
5.	Fundamentals of Traffic Engineering	Ricardo A. Daziano and Camille Kamga	Springer, ISBN: 978-3319502717

b) Online Educational Resources (OER):

1) Overview and Fundamentals of ITS - U.S. Department of Transportation https://www.its.dot.gov/factsheets/pdf/its_overview.pdf
2) ISO Standards for ITS https://www.iso.org/ics/03.220.01/x/
3) IEEE Intelligent Transportation Systems Society https://its.ieee.org/
4) ETSI ITS Standards and Activities https://www.etsi.org/technologies/intelligent-transport

5) Indian ITS Initiatives (NITI Aayog Report)
https://niti.gov.in/sites/default/files/2021-08/Smart_Transport_Systems_India_0.pdf
6) Traffic Surveillance and Video Detection
https://www.sciencedirect.com/topics/engineering/video-surveillance
7) Freeway Management Systems and Ramp Metering
https://ops.fhwa.dot.gov/freewaymgmt/ramp_metering.htm

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A)	**Course Title:** Project	Deemed to be University under Distinct Category
B)	**Course Code:** PD01	
C)	**Pre-requisite Course (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.
- 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**				

S. No	Activities	Target Duration	Responsibility	Formative Assessment Marks Weightage	Output Expected
	Submission of draft report	Week XIV		20	Draft Report
	• 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:**

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.
2.4	**Resourcefulness**	Demonstrates exceptional initiativeness and creativity in	Shows good use of resources and tools. Demonstrate moderate	Makes basic use of resources with limited initiative.	Shows poor ability of utilizing/arranging resources.

S. No.	Criterion	Very Good (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
		utilizing/arranging resources effectively.	initiativeness and creativity in utilizing/ arranging resources.	Relies heavily on guidance.	
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, hence enhancing the overall quality of the report.	Language is generally clear and appropriate. Style is mostly formal and consistent. The quality of the report is acceptable.	Language is understandable, but is informal. Style occasionally deviates from the formal standards. The quality of the report is moderate	Language is unclear, informal, or inappropriate for a technical report. Style is inconsistent and affects the quality of the report.
4.2	**Quality of Related Diagrams/ Drawings/ 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.

S. No.	Criterion	Very Good (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
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	**Comprehension 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	**Communication 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, icons). Fonts, size, colours, and layout enhance readability.	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.
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

S. No.	Name	E-mail Address
1.	Prof. Sanjay Agrawal	sagrawal@nitttrbpl.ac.in
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Course Curriculum Detailing- Online Spell -1

A)	**Course Title:** Research Methodology	Deemed to be University under Distinct Category
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

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.

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	**Unit -5.0 Research Proposal**	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 5b. Write good research proposal *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	5.5 Getting Started to Write a Research Proposal 5.6 Tips for Compilation 5.7 Scientific writing: types of scientific report 5.8 Structure and components of a conference 5.9 Arts of writing, ethics, and scientific conduct 5.10 Journal articles and thesis writing 5.11 Plagiarism	

J) Suggested Laboratory Experiences: (Not Applicable)

K) Suggested Research Based Problems

i. 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.

ii. 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

iii. 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

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)

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 Development Team

S. No.	Name	E-mail Address
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A)	**Course Title:** Curriculum & Assessment	Deemed to be University under Distinct Category
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.

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.

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**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 3a. Identify the roles of different stakeholders in effective curriculum implementation. *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.	**Unit-3.0 Curriculum Implementations & Evaluation** 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).	**CO3, CO4**
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	**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	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 4f. Design different types of questions	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. 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.

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
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.LOKANADHA 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 Development Team

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A)	**Course Title:** Indian Knowledge System (IKS)	Deemed to be University under Distinct Category
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 (-)

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)	
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**

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.

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.

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.

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

A)	**Course Title:** MOOC Creation	Deemed to be University under Distinct Category
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 toensuretheaccomplishmentoffollowingindustryexpectedcourseoutcomesbythelearners.

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.

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.

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.	**Unit-4.0 MOOC Course Configuration on LMS and its Guidelines** 4.1 SWAYAM Guidelines for MOOC development.	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant CO Number(s)
TSO 4c. Verify that all MOOC components developed adhere to LMS guidelines. *TSO 4d.* Upload MOOC components on ePrashikshan. *TSO 4e.* Test the MOOC course using the pre-launch checklist.	4.2 Overview of SWAYAM MOOC structure. 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

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

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

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A)	**Course Title:** Learner Centric Instructional Methods	Deemed to be University under Distinct Category
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.

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.

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

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

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

S. No.	Name	E-mail Address
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2.	Prof. Chanchal Mehra	cmehra@nitttrbpl.ac.in

****

A)	**Course Title:** Intellectual Property Rights (IPR)	Deemed to be University under Distinct Category
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.

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 different advanced software tools for analysis and design in the field of Green Technology.	**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 knowledge 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.

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). *TSO 1b.* Enlist the types of IPR and the type of protection it offers to a product. *TSO 1c.* With the example of any product explain how the IPR is enforced on a product *TSO 1d.* Name the Legislations Covering different types of IPRs in India. *TSO 1e.* Explain the need and significance of IPR policy in an Institution. *TSO 1f.* Differentiate between limited and unlimited IP with examples	**Unit-1.0 Introduction to IP, IPR and its enforcement** 1.1 IP and IPR – Concept, need and its significance 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 1.3 Enforcement of IP on a given product, Overlapping rights 1.4 Legislations Covering IPRs in India 1.5 IPR Policy – Need and significance 1.6 Limited life and Unlimited life IPS	**CO1**
TSO 2a. Explain the need and significance of patent/Copyright/GI/ Plant variety and farmer's right/Traditional knowledge *TSO 2b.* Enlist the criteria for protection under patent/Copyright/GI/ Plant variety and farmer's right/Traditional knowledge *TSO 2c.* List the work protected under patent/Copyright/GI/ Plant variety and farmer's right/Traditional knowledge *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 *TSO 2e.* Describe in brief every step of process of patenting/Copyright /GI with the help of a flowchart	**Unit-2.0 Patent, Copyright and related rights, Geographical Indications, Plant Varity 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. 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. 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. 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.	**CO2**

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. *TSO 3b.* Enlist the criteria for protection under of Industrial Design/ Layout design of Integrated Circuit/ Trademark/Trade secret. *TSO 3c.* List the work protected under Industrial Design/ Layout design of Integrated Circuit/Trademark/Trade secret. *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 *TSO 3e.* Explain the strategies to protect trade secret in India with 2 examples	**Unit-3.0 Layout design of Integrated Circuits Industrial Designs, Trademark and Trade secrets,** 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. 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. 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. 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.	**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.

- 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.
- 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

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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15. Annexure

15.1 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)

Deemed to be University under
Distinct Category

NATIONAL INSTITUTE OF TECHNICAL TEACHERS' TRAINING AND RESEARCH (NITTTR), BHOPAL

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Madhya Pradesh, India

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