Jharkhand University of Technology
Ranchi, 834010

TENTATIVE SYLLABUS

For Diploma Program in
Civil Engineering

(Effective from 2025-26)

DEPARTMENT OF CIVIL ENGINEERING

(5th – SEMESTER)

TRANSPORTATION ENGINEERING

Course Code- L:T:P-

Introduction: Welcome to the curriculum for Transportation Engineering Specialization. This specialization course is taught in Boot camp mode. Boot camps are 12 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning. In this course, you'll learn to investigate, plan, analyze, design, execute, and maintain Transportation systems.

Leading to the successful completion of this boot camp, you shall be equipped to either do an internship at an organization working in Transportation Engineering related industry or do a project on Transportation Engineering.

After the completion of your Diploma, you shall be ready to take up roles like Junior Engineer, Transport Planning Data Surveyor, Designer, Entrepreneur, Consultant, Contractor, Road Safety Auditor or can work or have your own Consultancy Services for Material Testing, Planning, Construction and Management of Transportation facility.

This course will teach you Fundamentals of data collection, data analysis, forecasting, design, drafting, evaluation, estimating and costing, Construction, management and maintenance of different components of Transportation System. Details of the curriculum is presented in the sections below.

Transportation engineering is the application of technology and scientific principles to the planning, functional design, construction, operation, maintenance and management of facilities for any mode of transportation in order to provide safe, efficient, rapid, comfortable, convenient, economical, and environmentally compatible movement of people and goods with respect to time and space.

The facilities support Surface (Road and Railways), air and water transportation. The design aspects of transportation engineering include the sizing of transportation facilities how many lanes or how much capacity the facility has, determining the materials and thickness used in pavement, designing the geometry (vertical and horizontal alignment) of the roadway or track. Operations and management involve traffic engineering, so that vehicles move smoothly on the road or track, transportation Structures like Bridges, Tunnels, Retaining Walls, Flyover and Underpasses. Transportation engineering emphasizes on Road safety and assess environmental and health impacts.

Pre-requisites:

Before the start of this specialization course, you would have completed the following courses;

In the 1st year of study, you would have studied Engineering Mathematics, Communication Skills, Civil Engineering Graphics, Statistics & Analysis, Basic IT Skills, Basic Surveying, Fundamentals of Electrical and Electronics Engineering, Project Management skills, Construction Materials, Environmental Sustainability.

In the 2nd year of study, you would have studied Engineering Mechanics and Strength of Materials, Modern Surveying, Construction Techniques, Building Drawing using CADD, Concrete Technology, Building Estimating and valuation, Site Management, Design and detailing of RCC structures.

In this year of study, you shall be applying your previous years learning along with specialized field of study into projects and real-world applications.

Instruction to course coordinator:

1. Each Pathway is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. Single faculty shall be the Cohort Owner.
3. This course shall be delivered in boot camp mode.
4. The industry session shall be addressed (in contact mode/online / recorded video mode) by industry experts only.
5. The cohort owner shall identify experts from the relevant field and organize industry sessions as per schedule.
6. Cohort owner shall plan and accompany the cohort for industrial visits.
7. Cohort owners shall maintain and document the industrial assignments and weekly assessments, practices and mini projects.
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table.
9. The cohort owner along with the classroom can augment or use for supplementally teaching online courses available although reliable and good quality online platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM, etc.
10. Cohort owner shall guide the cohorts for the execution of mini project.

Course outcome: At the end of the semester students will be able to,

CO1	Conduct Surveys to fix the alignment of the road and prepare Geometric design required for the alignment of road construction and study the traffic flow and behavior of vehicular movement at intersection, traffic engineering characteristics, regulations and control which helps to collect various traffic data and conduct accident analysis

CO2	Investigate Soil and pavement materials , Prepare Alignment Drawings, Pavement design and select suitable equipment/ machinery and Suggest suitable pavement construction methodology for road construction and take required safety precautions during road construction
CO3	Design suitable surface drainage system for road construction Estimate the road works to determine construction, operation and annual cost and suggest suitable soil stabilization technique and recommend suitable repairs technique with regular maintenance skills having a knowledge of highway financing
CO4	Compare between different types of railway systems with Local Bus transport system and differentiate between different modes of transportation system(surface, water and air) and suggest suitable transportation structure for the transportation project
CO5	Conduct road safety auditing and Assess environmental and health impact and Select the appropriate tools, production environment and deploy the model.

Detailed course plan

Week	CO	PO	Days	1st session (9am to 1 pm)	L	T	P	2nd session (1.30pm to 4.30pm)	L	T	P
1	1	1,2	1	**Audio-Visual Presentation on** **Introduction to Specialization :** Importance of transportation Engineering, Role of Transportation in national development- Economic, Social, Spatial, Cultural and Political Development **Road Transportation – Surface Transportation** 1. Formation of Jayakar Committee and its recommendations and Implementations 2. Importance of Indian Road Congress (IRC) Committees and Sub committees, Importance of IRC Codal Provisions 3. Characteristics of Road Transportation , Saturation system, its advantages and limitations **Case Exercise (Tutorial)** • Study and prepare report on Ongoing National Level highway Development Plan (NHDP) and Improvement of	3		1	**Audio-Visual Presentation on** 1. Highway alignment, Major ideal requirements of highway alignment 2. Factors affecting Highway alignment, Steps to be followed in new highway alignment 3. Engineering Surveys for New highway alignment, Drawings and Report 4. Phases of New Highway Project **Case Exercise (Tutorial)** • Study Different Class of roads- National Highway (NH), State Highway(SH), Major District Roads(MDR), Other District Roads(ODR) and Village roads(VR) • Study on detailed report preparation of New Highway Project (Real Time Project Report)	2	1	

				Riding Quality Programme(IRQP) • Study and prepare report on Present Scenario of Road Development in India							
	1	1,2	2	**Audio-Visual Presentation on** 1. Realignment of highways, Objectives of Realignment, Steps to be followed in highway realignment 2. Study of Different Road Patterns- Rectangular , Radial or Star and Block , Radial or Star and Circular, Hexagonal Pattern 3. Importance of Curves in Road and Railway alignment, Curves- Elements of Curves, relation between Radius and Degree of a curve 4. Types of curves – Horizontal and vertical curves.	2		2	1. Elements of Horizontal Curves- • Simple Curve • Compound Curve • Reverse Curve • Transition curves 2. Procedure for Setting out Simple curve by Rankine's method using Total Station (Deflection Angle Method) 3. Procedure for Setting out Compound curve by Rankine's method using Total Station (Deflection Angle Method) 4. Procedure for Setting out Reverse Curve between Two Parallel Lines using Total Station (Deflection Angle Method)			3
	1	3	3	**Field Practice** 1. Set out simple curve by Rankine's method using Total Station in field			4	**Audio-Visual Presentation on Geometric Design – IRC 38** 1. Importance of highway geometrics 2. **Geometric Design Control and Criteria**: Design Speed, Topography or terrain, Traffic factors, Design			3

				2. Set out Compound curve by Rankine's method using Total Station in field 3. Set out Reverse Curve between Two Parallel Lines by Deflection Angle Method using Total Station in field				hourly Volume and Capacity, Environmental and other factors 3. **Highway Cross Section Characteristics** : Pavement Surface Characteristics, Friction, Pavement unevenness, Light Reflecting Characteristics			
	1	4	4	**Audio-Visual Presentation on** 1. **Cross Sectional elements** – Cross slope or Camber, Width of carriage way, Medians, Kerb 2. Road Margins : Shoulders, guard rail, Foot path, drive way, cycle track, parking lane, bus bay, frontage roads and embankment slopes, cut slopes 3. Right of Way or Width of Formation: Factors affecting Right of way **Case Exercise**: Refer the following 1. IRC recommendations of Right of Way Width for different types of roads 2. IRC 38 - Guidelines for Design of Horizontal Curves for Highways and Design Tables	1		3	1. Drawing and detailing of typical Cross section of roads • Cross Section in Embankment • Cross Section in Cutting • Cross section of VR or ODR in embankment in rural area • Cross section of MDR in cutting in Rural area • Cross section of two lanes in city in Urban area **Audio-Visual Presentation on** 1. **Types of Sight Distance:** • Stopping Sight Distance(SSD) • Over Taking distance(OSD), • Sight Distance at Intersections • Intermediate Sight Distance(ISD) • Head Light sight distance(HSD) for night driving			3
	1		5	**Developmental Assessment**				Assessment Review and corrective action			3
	1	7	6	Industry Session:	1		4	*Industry assignment*			

				1.Importance and Applications of transportation engineering studies in Industry 3. Establish link between Transport Planning, Traffic studies, Designs , Material Testing for Quality Control, Construction and Maintenance of Transportation system 4. Phases of Highway Project and its Report Preparation							
2	1	3,7	1	*1. Peer review on industry class.* *2. Review of Case exercises* *3.* Refer Law resources IRC codal Provisions : https://law.resource.org/pub/in/bis/i rc		4		**Audio-Visual Presentation on** 1. Factors affecting SSD and OSD, Standard values of SSD and OSD for different design speed as per IRC ,Expressions for calculating SSD , ISD, HSD, OSD, Overtaking zones 2. **Elements of Horizontal Alignment** – Objectives and Expressions for the following • Design speed • Type of Curve provided • Super elevation • Extra width at curve • Setback distances and Curve resistance			3
	1	3	2	1. **Numerical problems** on the following • Cross sectional elements • Types of sight distances • Design of elements of horizontal alignment	1		3	**Types of Vertical curves**: Summit Curves or crest curves, Valley curves or Sag curves 1. Length of Summit curves and Valley curves, and its expressions 2. Design criteria for summit curve and Valley curves	1		2

				2. **Audio-Visual Presentation on Vertical alignment-** 1. Types of gradient : Ruling gradient, Limiting gradient, Exceptional gradient and minimum gradient 2. Grade Compensation at curves				3. Numerical Problems on design of elements of Vertical alignment Reference : IRC SP 23			
	1	3	3	**Audio – Visual Presentation on Traffic Engineering** • Introduction to Scope of Traffic Engineering • Road User characteristics • Vehicular characteristics • Fundamental Parameters and Relations of Traffic Flow (Q), Density (K) and Speed (V), Travel Time. • Spot speed, Time Mean Speed, Space mean speed, Time headway and Distance headway • Simple numerical problems	1		3	**Audio – Visual Presentation on Traffic Engineering Studies** **1. Traffic Volume Characteristics** • Traffic Flow- PCU, PHF, PCU values recommended by IRC • Traffic Volume studies and Pedestrian Volume studies • Manual and Automatic traffic volume counting methods • Measurement and analysis of Traffic Volume data- AADT, ADT, AAWT,AWT • Simple Numerical Problems on Peak hour Volume and Peak hour factor using PCU values **2. Spot Speed studies** • Uses and factors affecting spot speed studies • Measurement of spot speed study- a) Stopwatch method b) Radar meter method	1		2

								c) Pneumatic road tube method • Frequency Distribution diagram of Spot speed from data • Simple Numerical Problems			
	1	3	4	**Audio – Visual Presentation on** **3. Speed and Delay studies** • Objects and uses of speed and delay studies • Methods of conducting Speed and delay studies a) Floating car / moving observer method. b) License plate method c) Interview technique d) Elevated Observations e) Photographic technique • Simple numerical problems on Determination of Flow, Density and Speed using Moving observer method **4. Origin and Destination Studies** • Objects, types and applications of Origin and Destination studies • Methods of conducting Origin and Destination studies- data collection a) Home Interview method b) Road side Interview method c) License plate method	1		3	**Audio – Visual Presentation on** **5. Parking studies** • Need and effect of parking • Investigations for parking studies • Parking characteristics • Parking demand • Method to determine parking demand **6. Accident Studies** • Importance of accident studies • Causes of accidents • Collection of accident data, report and records • Accident Investigations • Accidental analysis • Measures of reduction of accident rate **a)** Engineering **b)** Enforcement **c)** Education • Simple problems on accidental analysis **Case exercise(Tutorial)**	1		2

				d) Return post card method e) Tag on vehicle method • Sampling in O-D studies				**1.**Study real time Accidental investigation and analysis report to understand the methods and steps followed and measures suggested to reduce the accident				
	1		5	**Developmental Assessment**				Assessment Review and corrective action				3
	1	7	6	*Industry session-* Introduction to highway geometric design softwares and its application • ***MX ROAD*** • ***CIVIL 3D***	1		4	*Weekly industry assignment.*				
3	1	1	1	*1. Peer review on industry class.* *2. Review of Case exercises*		4		**Audio Visual presentation on Capacity and Level of Service** • Factors affecting level of service • Design Capacity and design service volumes for different capacity roads **Inventory of Transport Facilities** • Inventory of Streets • Traffic Volume • Travel Time Studies • Inventory of Public Transport Buses • Inventory of Rail Transport Facilities • Parking Inventory • Accident Data	1		2

								• Land Use and Economic Activities **Case exercise(Tutorial)** **1.** Prepare a presentation on Traffic Regulations and Control measures 2. Economic loss caused by Inferior traffic facilities			
	1	4	2 3 4	**Project 1 : Traffic Engineering** **Field survey** : Conduct the following surveys and collect data in a given area on selected stretch of major road to determine the Level of Service of that road as per IRC standards 1. Traffic Volume and composition study by Manual counting method 2. Spot speed study by manual method 3. Origin and Destination survey of an area by Home Interview survey and Road side Interview survey 4. Parking Vehicle Compositions **Graded Exercise and Report** 1. Classified traffic Volume count by converting count into PCU values using tables 2. Representation of traffic composition using tables and charts (Pie charts/ Bar charts) 3. Representation of spot speed of vehicles in frequency distribution diagram using tables and charts (Line chart) 4. Representation of Parking vehicle composition using tables and charts (Pie chart / Bard chart) 5. Home interview and road side interview data on O-D study using standard formats and tables 6. Collection of accidental data of that selected major road of a given area from relevant sources and prepare Vehicle interference diagram related to accident analysis 7. Determination Level of Service of the given road as per IRC standards based on data 8. Representation of Projected yearly traffic growth using bar chart						21
			5	**CIE 1– Written and practice test**				Assessment Review and corrective action			3
	1	4	6	*Industry class- -*	1		4	*Weekly industry assignment.*			

				1 Introduction to Traffic study and simulation softwares and its application • ***DATA FROM SKY*** • ***VISSIM***							
4	2	4	1	*1.Peer review on industry class* *2.Presentation by students on* Traffic Regulations and Control measures		4		**Types of Pavements- Audio Visual Presentation** 1. Need for highway pavement 2. Structure of flexible pavement and Rigid Pavement 3. Functions of flexible and rigid pavements 4. Basic Difference between rigid and flexible pavement 5. Advantages of flexible and Rigid pavements 6. Limitations of flexible and Rigid pavements	2		1
	2	4	2	**Audio-Visual Presentation on FLEXIBLE PAVEMENT** 1. Flexible Pavement layers – Subgrade, Sub base, Base course, Surface course, Wearing course and its functions 2. Soil as Subgrade layer - Application of Soil Mechanics in Road Construction	2		2	**1. Laboratory procedure to determine following Index properties :** • Water content • Specific gravity • Particle Size distribution • Consistency limits • Insitu Density 2. **Soil Classification Systems**: IS classification system and AASHTO classification 3. Numericals on determining index properties	1		2

				3. Three Phase system of Soil, Water Content, Density, Unit weights, Specific Gravity, Void Ratio, Porosity and Degree of Saturation, its functional relationships 4. Introduction to Index properties and engineering properties of soil.				4.Numerical on Soil Classification by IS system and HRB systems			
	2	4	3	**LAB EXPERIMENTS** 1. Conduction of experiment to determine water content in the given sample of soil by oven drying method and Pycnometer method 2. Conduction of experiment to determine Specific Gravity in the given sample of soil 3. Conduction of experiment to determine Particle Size Distribution in the given sample of soil by Dry Sieve analysis			4	**LAB EXPERIMENTS** 1. Conduction of experiment to determine liquid limit by Casagrande's apparatus 2. Conduction of experiment to determine Plastic limit by method of rolling 3. Conduction of field experiment on determination of In-situ Density of soil by Core Cutter method / sand replacement method **Case Exercise :** Importance of soil testing for Index properties in determining type and behavior of soil for road construction			3
	2	4	4	**Audio Visual Presentation** 1. Importance and factors affecting the Engineering properties of soil : Shear	1		3	**LAB EXPERIMENTS** 1.Conduction of Dynamic Compaction test for the given sample of soil by Modified Proctor test method			3

				strength , Compaction and Permeability of soil 2. Procedure for determining the Optimum moisture content and Maximum Dry density of Soil by Modified Proctor Compaction test 3.Procedure for determining Strength of soil by California Bearing Ratio test (CBR)				2. Conduction of CBR test for the given sample of soil 3.Laboratory Experiments on Soil - Review of results and corrective action **Case Exercise :** Importance of soil testing for Engineering properties in determining type and behavior of soil for road construction			
	2		5	**Developmental Assessment**				Assessment Review and corrective action			3	
	2	4	6	*Industry class – Consultancy Services* *1.Soil Testing* *2. Swelling Index Test of Soil – Importance and test procedure*	1		4	*Weekly industry assignment.*				
5	2	2,3	1	*1. Peer review on industry class* *2. Review of Case exercises* *3. Review of **Project 1***				**Introduction to Pavement Materials: Aggregates** 1. Origin, Classification and Properties of aggregates to be considered for road construction 2. Laboratory Test procedure on aggregate to be considered for road construction as per IS codes and **MORTH** specifications • Impact test • Abrasion test • Polished stone Value test(Only for Demonstration) • Crushing test	1		2

								• Flakiness and Elongation Index test and angularity Number • Specific gravity and Water Absorption test			
	2	4,5	2	**LAB EXPERIMENTS** 1. Conduction of Experiment for determining the toughness / resistance to Impact of aggregates by Aggregate Impact Test 2. Conduction of Experiment for determining the Hardness / Resistance to Abrasion of aggregates by Los Angeles Abrasion test 3. Conduction of Experiment for determining the resistance to crushing of aggregates by Aggregate Crushing Test			4	**LAB EXPERIMENTS** 1. Conduction of Experiment for determine the Specific Gravity and Water absorption of aggregates 2. Conduction of Experiment for determining the shape of aggregates by Flakiness and Elongation test 3. Conduction of Experiment for determining the shape of aggregates by Angularity Number **Case Exercise :** Study MORTH Specifications on the results of each tests for inference of its application in road construction			3
	2	4,5	3	**Introduction to Pavement Materials-Binder** Audio – Visual Presentation 1. Origin of Asphalt , Bitumen and Tar and its types 2. Chemical Composition of Bitumen and Tar, Differences between Bitumen and Tar and its grades	2		2	1. Functions of binder as Pavement Material and desirable properties 2. Laboratory Test procedure on bitumen to be considered for road construction as per IS codes and MORTH specifications • Penetration test • Ductility test • Softening point test • Specific gravity test	1		2

				3. Introduction and Applications of following bitumen used in road Construction • Cut back Bitumen • Bitumen Emulsion • Modified Bitumen				• Viscosity test • Flash and Fire point test • Float test • Water content test • Loss on heating test • Stripping Value test (Adhesion between Bitumen- aggregate)			
	2	3,4, 5	4	**LAB EXPERIMENTS** 1. Conduction of Experiment for determining the consistency of bituminous material by Penetration test 2. Conduction of Experiment for determining the Ductility or malleability of bituminous material by Ductility test **3.** Conduction of Experiment for determining the Temperature at which bituminous material softens by Softening point test **4.** Conduction of Experiment for determining the Specific Gravity of bituminous material softens by Pycnometer Method			4	**LAB EXPERIMENTS** 1. Conduction of Experiment to determine the rate of flow of bituminous material by viscosity test using Orifice Viscometer 2. Conduction of Experiment for determining the Temperature at which bituminous material catches flash and fire (Safety)by Flash and Fire Point Test 3. Conduction of Experiment for determining the adhesion of bituminous material on the surface of aggregate by Stripping value test of aggregates **Case exercise** : IRC and MORTH Specifications on the results of each tests for inference of its application in road construction			3
			5	**CIE 2– Written and practice test**				Assessment Review and corrective action Laboratory tests on pavement material-Soil,			3

								Aggregate and Bitumen - Review of results and corrective action			
	2	4,5	6	*Industry class-* *1. Consultancy Services – Pavement Material Testing* *2. Partial Replacement of pavement materials with recycled materials / sustainable materials in pavement construction*	1		4	*Industry weekly assignment*			
6	2	1,3	1	*1.Peer review on industry class* *2. Review of Case exercises*		4		**Bituminous Paving mix** : 1. Gradation and proportioning of aggregates by Rothfutch method 2. Step wise Procedure for preparation of Bituminous trial mix 3. Procedure to determine the Stability, Flow Value and Optimum Binder Content of Bitumen trial mix by Marshal Stability test 4. Demonstration of the experiment to check the Marshal Stability for the Bituminous mix prepared from Mix design	1		2
	2	2,3	2	**Audio-Visual Presentation on RIGID PAVEMENT** 1. Components of Cement Concrete Pavements and their functions 2. Rigid Pavement Layers- Subgrade, Granular sub base/ Drainage layer, Dry Lean Concrete sub base, Pavement Quality Concrete Slab and its functions	2		2	1. Prepare Dry Lean Concrete (DLC) and Pavement Quality Concrete(PQC) mix design for Pavement as per IS standards 2. Conduct experiment to determine the Compressive and Flexural strength of concrete mix prepared from the mix design as per IRC 44 2017			3

				3.Material Specifications for the construction of Cement Concrete Pavements- Cement, Coarse aggregates, Fine aggregates, Water and admixtures 4. Requirements of Paving Concrete 5. Different Types of Joints and their functions in Cement Concrete pavements							
	2	2,3	3	**Design of Flexible Pavement**: **(IRC 37 2018)** **1.** Functional and Structural requirements of road pavements 2. Factors governing the design of flexible pavement • Wheel loads of heavy vehicles or traffic loads and contact pressure- ESWL • Sub grade soil • Climatic factors • Pavement Component material • Environmental Factors • Special factors in the design of different types of pavements 3. Design approach and criteria • Estimation of design traffic • Design life • Vehicle Damage Factor (VDF) • Distribution of Commercial Vehicle Traffic	1		3	1. Stresses and deflection in flexible pavements and its expressions 2. Numerical problems on determination of design factors ESWL and VDF 3. Numerical problems on IRC method of Design of Flexible Pavement			3

				• Growth rate							
	2	2,3	4	**Design of Rigid Pavement**: **IRC 58 2015** 1.Factors governing the design of rigid pavement and its Standard values and expressions as per • Wheel load • Temperature differential • Types of Joints and their spacing • Characteristics of Subgrade and Sub base • Drainage layer 2. Characteristic strength and Fatigue behavior of Concrete 3.Stresses in Rigid Pavements and its analysis	1		3	1. Numerical problems on determination of design factors like design loads 2. Numerical problems on IRC method of Design of Rigid Pavement			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	2	2,5	6	*Industry Class- Special types of pavements* *Example :* • *Semi Rigid pavements* • *Composite Pavements* • *Interlocking Cement Block Pavements* • *Continuously reinforced concrete pavements*	1		4	*Industry weekly assignment*			

				• *Steel fiber reinforced concrete pavements*							
7	2	2,5	1	*Peer review on industry class*		4		**Flexible Pavement Construction: Audio – Visual Presentation as per MORTH Specifications** 1. Introduction , Components of Highway in embankment and cutting 2. Embankment and Subgrade: Functions and Design elements of highway Embankment and Subgrade 3. Construction methodology of highway embankment and Subgrade- Material Specifications, Construction Methodology and Quality Control checks 4. Compaction of soil for the construction of Embankment and Subgrade **Case Exercise (Tutorial) :** Equipments ,Machineries and Rollers used for Compacting soils and Excavation of earth for road construction			3
	2	7	2	**Construction of Flexible Pavement: Audio – Visual Presentation** 1. Material Specifications, Construction Methodology and Quality Control checks for the following Components of flexible pavement	1		3	**Construction of Flexible Pavement: Audio – Visual Presentation** 1. Material Specifications, Construction Methodology and Quality Control checks for the following Components of flexible pavements • Prime Coat and Tack coat	1		2

				• Granular sub base drainage layer • Granular Base course a) Wet Mix Macadam(WMM) b) Water Bound Macadam(WBM)				• Bitumen Base Course- a) Bituminous Macadam (BM) b) Bituminous Penetration Macadam(BPM) c) Built-up Spray Grout(BUSG)			
	2	7	3	**Construction of Rigid Pavement: Audio – Visual Presentation** 1. Material Specifications, Construction Methodology and Quality Control checks for the following Components of flexible pavements • Bitumen Surface Course • Dense Graded Bituminous Mixes • Bitumen Mastic Wearing course • Stone Mastic Asphalt (SMA) **Case Exercise :** Bitumen Paver Machines and Equipments used in road construction	1		3	**Audio – Visual Presentation on Construction of Rigid Pavement** 1. Material Specifications, Construction Methodology and Quality Control checks for the following Components of flexible pavements • Subgrade and Drainage layer • Dry Lean Concrete sub base Layer • Separation membrane • Pavement Quality Concrete pavement slab • Construction of joints in rigid pavements **Case Exercise :** Machines and Equipments used in rigid pavement construction	1		2
	3	7	4	**Audio – Visual Presentation** **Introduction to Road Drainage works- IRC –SP- 42** 1. Objectives of road drainage 2. Requirement of highway drainage 3. Types of drainage system a) Surface drainage system	1		3	1. Standard values and expressions as per IRC 2. Numerical Problems on Design of Surface drainage for roads **Low Volume Roads** • General features of low volume roads • Construction of Earthen roads • Construction of Gravel roads	1		2

				b) Sub surface drainage systems c) Cross drainage system 4. Design procedure of surface drainage				• Construction of Surface roads • Construction of Low Volume CC roads			
			5	**CIE 3– Written and practice test**				Assessment Review and corrective action			3
	3	7	6	*Industry Class* *1.Subgrade Soil Stabilization techniques and its importance* *2. Pavement Repairs* *3.Pavement Maintenance* *4.Highway Finance*	1		4	*Industry weekly assignment*			
8	3	1,2	1	1. *Peer review on industry class-* 2.Review of Case Exercises 3.Progress review of **Project 1**		4		**<u>ESTIMATION OF ROAD WORKS</u>** Detailed Estimates and Abstract of Cost of Road work. 1. Compute earth work quantities from given cross sectional details. 2. Preparation of Detailed Estimates and Abstract of Cost of Bituminous & concrete Roads 3. Numerical Problems on Estimation of Operational Cost of highway project 4. Numerical Problems on Estimation of Annual cost of Highway project			3
	2	1,2	2	**Project 2 : Pavement Construction Site visit**							

	2	7	3	• Observe and Study about Constructional aspects and methodology for sub grade, sub base, base, bituminous coarse / concrete pavements • Observe and Study different types of Equipments, Machineries and Rollers used • Observe and Study the Safety precautions taken during Pavement Construction • Collect the data about Project details like Type of Soil and its investigations, Pavement materials used and tests conducted , Preparation of pavement layers, setting / curing period and special techniques and latest technologies if any • Preparation of Report on Site visit							14
	3	7	4	**Assignment** 1: Conduct a site visit to make the students to observe the highway maintenance works and prepare a report • To check the riding quality of all types of pavement surfaces represented in terms of unevenness index using response type road roughness measuring equipment like Bump Integrator or any other approved equipment • To conduct structural evaluation of flexible pavements by Benkelman Beam Deflection method							7
			5	**Developmental assessment**				Assessment Review and corrective action			3
	2	7	6	*Industry Class-* Introduction to PAVEMENT DESIGN and EVALUATION Softwares and its application 1.PAVEMENT DESIGN- • KENPAVE • IITPAVE 2.PAVEMENT DESIGN AND EVALUATION • KJPBACK	1		4	*Industry weekly assignment*			
9	1,2 ,3	7	1	1. *Peer review on industry class* 2.Progress review of **Project 2 and assignment 1**			**4**	**Project 3 :** **Proposal of New Highway Alignment Project** – Survey, Drawings and Report			

								Field Survey - • Reconnaissance survey of the area • Preliminary survey - Data collection- Primary traverse, Topographical feature study, Levelling work, Drainage studies, hydrological data, soil and material survey			
	1,2,3	7	2	**Project 3** 1. **Traffic Survey**- Data Collection – Conduct House Hold Interview Survey in nearby area to determine traffic volume on the proposed road **2. Field Survey -** Terrain to be chosen for survey such that it should include vertical & Horizontal curve – Conduct Survey using Modern Equipments like **Total Station** Align a new road between two obligatory points. • Conduct Longitudinal and cross-sectioning surveys • Projecting a road of given gradient. • Blockleveling at the lowest level or valley curve • Connecting to new road alignment, surveying existing road 90m and exploring possibility of widening. 3. **Graded Exercise** : Preparation of **AUTOCAD** Drawings / CIVIL 3D software • Key Plan and Index plan • Plan showing alignment with Horizontal Curves of road and Section of Vertical curves • L.S & C.S of Road at different chainages as per IRC standards (Report should justify the selected alignment with details of all geometric designs for horizontal curve and Vertical curves for the traffic volume and design speed to the proposed alignment) • Typical Cross Section of Road as per Pavement Design • Block leveling @ the lowest level or valley curve placing Culvert – Cross Drainage works o Half plan at top & half plan at foundation. o Half sectional elevation, half front elevation.						21
	1,2,3	7	3								
	1,2,3	7	4								

				○ Half Cross section @centre half Cross section @ abutment 3. **Quantity surveying** • Earthwork Calculation from the cross-section area at different chainages using **Spreadsheet**. • Estimation of Cost of Construction and Maintenance of Proposed Project using **Spreadsheet**. **4. Project Planning** • Prepare Project Schedule for New Highway Alignment using **M S Project / Primavera** 5. **Experiments** • Field sample of soil to be collected and laboratory and insitu experiments to be conducted to determine the Index and engineering properties of soil- Subgrade and results to be reported • Based on Pavement design for type of pavement proposed – Pavement materials to be laboratory tested and results to be reported 6. **REPORT** • AUTOCAD Drawings • Geometric Design for horizontal curve and Vertical curves proposed • Pavement design for type of pavement proposed • Details of Cross Drainage work proposed • Soil Investigation Report • Pavement Material Testing Report • Quantity Surveying Report – Earthwork Calculation, Estimation of Cost of Construction and Maintenance of Proposed Project • Project Planning report								
			5	**CIE 4– Written and practice test**				Assessment Review and corrective action			3
	1,2,3	7	6	*Industry Class-* *1. Highway Lightings*	1		4	*Industry weekly assignment*			

				2.Sustainable Pavements *3. Economic way of Constructing pavements and its layers and its purpose Ex: Cement Treated Sub Base(CTSB)*							
10	4	1,2	1	*1. Peer review on industry class* 2. Progress review of **Project 2, 3 and Assignment 1**		4		**Audio Visual Presentation on** **Introduction to Railway Engineering (Surface Transportation)** 1. Role and Features of Indian Railways 2. Advantages of Railways- Political, Social and Economical 3. Various components and requirements of a good track 4. Factors to be considered while selecting a good alignment 5. Forces acting on the track 6. Concept of coning of wheels and tilting of rails, Gradient and its types	1		2
	4	1,2	2	**Audio Visual Presentation** on Functions, Types and requirements of Track Components • Track • Rails • Sleepers • Ballast	2		2	**Audio Visual Presentation** on Importance and Features of • Subgrade and Embankment • Gauges • Track Alignment ,fittings and Fastening • Rail Joints and Welding of Rails • Railway Stations and Yards	1		2
	4	1,2	3	**Audio Visual Presentation** on Importance and Features of • Points and Crossing • Turnouts • Track Junctions	2		2	**Audio Visual Presentation** on Importance and Features of • Track Drainage • Track Maintenance • Safety in Railways	1		2

				• Signaling and Control system				• Modernization of railway track and future trends- High and super high speed railway system **Case exercise (Tutorial)** Study on Types of Rail Transportation and prepare presentation • Sub urban Rails • Rapid Rail Transit • Light Rail Transit • Monorail			
	4	1,2	4	Audio Visual Presentation on **Harbour - Water Transportation** **1.** Introduction to Harbour, Purpose of providing Harbour 2. Terminology - Dock, Port, Sea works for transportation Breakwater, Jetties, Quays, Dredging, Light house, Buoys and Beacons. 3. Types of Harbor- Natural Harbor, Artificial Harbor, Ice-Free Harbors	1		3	Audio Visual Presentation on **Airport- Air Transportation** 1. Terminology- Aerodrome, Apron, Hanger, Runway, Taxiway, Terminal area, Wind rose 2. Factors affecting selection of site for airport 3. Advantages and Disadvantages of Airport 4. Importance of Airport Lighting	1		2
			5	Developmental Assessment				Assessment Review and corrective action			3
	4	1,2	6	*Industry Class-* ***Audio Visual Presentation on Construction stages/ phases of following***	1		4	*Industry weekly assignment*			

				1. Railways system and Underground Railways in tunnels ***2. Harbour system*** ***3. Airport system***								
11	4	1, 2	1	*1. Peer review on industry class* *2. Presentation on types of railway transportation* 2. Progress review of **Project 3**		4		**Audio – Visual Presentation on Introduction to Transportation Structures** 1. Bridges – Rail Bridge, Road Bridge and Pedestrian bridge 2. Tunnels and Culverts 3. Grade Separators - Flyovers (Overpass and Underpass) and Interchange 4. Retaining Walls in highways			3
	4	1, 2	2	**Audio Visual Presentation on** **Introduction to Bridges** 1. Component parts of a bridge 2. Terminologies - Water way, afflux, economic span of a bridge, scouring, free board, approach 3. Selection of site for bridges 4. Bridge Sub structure and Super structure	1		3	**Audio Visual Presentation on** 1. Types of Bridges based on Material • Temporary bridges – Timber bridges • Permanent bridges - Masonry, Steel or R.C.C / Pre stressed bridges 2. Types of Bridges based on Structure • Arch bridges and Tied Arch bridges • Beam Bridges • Truss Bridges • Cantilever Bridges	1		2

								• Cable stayed bridges • Suspension bridges			
	4	2, 6	3	Audio Visual Presentation on **Tunnels**: 1. Terminology 2. Advantages of tunnels 3. Size and shapes of tunnels- horse shoe, egg shape, segmental roof section 4. Transferring alignment inside the tunnel, mucking, concept of shafts 5. Objects of tunnel lining and Ventilation 6. Drainage in tunnels	2		2	**Assignment 2** : To be conducted In class in the form of Discussion and presentation 1. Compare the Local Bus transport system with the Metro Rails and Sub urban Railway systems (Completed)available in different cities of India 2. Compare the following parameters with respect to Roadways, Railways and Airport system : • Population of the cities • Project Completion Cost • Annual returns (Income) • Ridership per annum Report which transportation system is most economical in different cities of India 3. Compare between road pavement and runway pavement of airports **Assignment 3** : To be conducted in class in the form of Discussion and presentation Report the following 1. Cities/ Places in India where Harbours and Airports are situated			3

								2. Study salient features in the airports situated in different cities of India. 3. Project Completion Cost of those Harbours and Airports situated in different cities of India 4. Types of Airports and Harbours situated in India			
	4	6	4	Case study : Students shall be selecting different topics of interest on latest technology in transportation engineering, Conduct a case prepare a report and present Example: 1. https://bengaluru.citizenmatters.in/n o-potholes-in-electronics-city-roads- 80916 2. https://auto.hindustantimes.com/aut o/news/indias-first-ever-steel-road- opens-for-traffic-showcases- sustainable-model-41648449391277.html 3. https://www.icevirtuallibrary.com/d oi/10.1680/jcien.19.00046 4. https://www.iosrjournals.org/iosr-jmce/papers/AETM'15_CE/2/18-CE-128.pdf 5. https://pdfcoffee.com/whitetopping- pdf-free.html			4	**CASE STUDY 1** : Conduct a case study on the construction procedure of the following and prepare a report 1. Grade separators • Underpass • Flyover – Overpass • Interchange 2. Retaining wall in highway construction			3

			5	**CIE 5– Written and practice test**				Assessment Review and corrective action			3
	4	7	6	*Industry Class on* ***Audio Visual Presentation on Construction stages/ phases of following*** ***1. Bridges and Tunnels system*** ***2. Grade Separators, Interchanges and Retaining wall in highways***	1		4	*Industry weekly assignment*			
12	5	2	1	*1. Peer review on industry class* *2. Review of Assignment 2 and 3 and Case study 1*		4		Audio Visual Presentation on Introduction to Multi Modal Transportation system • Public Transport- Bus Rapid Transit System (BRT) and Light Rail Transit system (LRT) • Services and Freight • Intermediate Para Transit • Multi Occupancy Cars (Car Pool) • Marine transit system (Maritime) • Air transportation	1		2
	5	5	2	**Audio- Visual Presentation** on **Road Safety** 1. Pedestrian Safety and Security 2. Risk factors for Pedestrian Traffic Injury 3. Road Crashes/ Accidents 4. Factors influencing crashes	1		3	**Road Safety Auditing – IRC SP 88** 1. Different Types of auditing 2. Introduction to road safety auditing 3. Need of road safety auditing 4. Objectives of road safety auditing 5. Benefits of road safety auditing 6. Code of good practice and checklists	1		2

				5. Safety Precautions to be considered for Road safety							
	3,4	5		Audio- Visual Presentation on Stages of Road safety auditing 1. Auditing of Roads before opening to traffic • Feasibility stage • Preliminary design stage • Detailed design Stage • Pre –opening stage 2. Auditing of Existing roads • Accidental data collection • Inspection at Road Construction at accident black spot • Inspection of Designs • Assessment and Reviews	2		2	Audio- Visual Presentation on 1. Step wise procedure followed in the Road safety auditing 2. General and Formal requirements of Road safety auditing 3. Importance of Monitoring and Evaluation of road safety by auditing			3
	5	5, 6		Audio- Visual Presentation on 1.Environmental Impact Assessment of Transportation projects • Screening and Scoping • Establishing Baseline • Impact Assessment • Mitigating Impacts • Monitoring and Evaluation 2.Health Impact Assessment of Transportation projects • Current exposure to emissions (air and noise pollution)	2		2	**CASE STUDY 2 : :** Students shall be selecting different topics of interest on following topics , Conduct a case study, prepare a report and present • Road safety auditing Example : https://www.researchgate.net/publication/325116717_Road_safety_audit_a_case_study_on_NH-65			3

				• Traffic Injury and Fatalities • Current level of Physical activities				• Environmental and Health Impact assessments of transportation systems Example : https://www.researchgate.net/publication/335365145_Impact_Assessment_of_Road_Construction_on_Rural_Accessibility_A_Case_Study_in_India • Sustainability – Reclaimed Asphalt Pavement • Usage of alternative materials in road construction Example: 1. https://www.researchgate.net/publication/346892421_Case_Studies_of_Sustainable_Road_Transport_Practices_in_Different_Industry_Sectors_in_India 2. https://www.fhwa.dot.gov/pavement/sustainability/case_studies/			
			5	Developmental assessment				1. Assessment Review and corrective action 2. Review of **Case study 1 and 2**			3

References:

Sl. No.	Description
1	" Highway Engineering " by Khanna S.K. and Justo C.E.G, , Nemchand and Bros, Roorkee
2	" Highway Material Testing Laboratory Manual" by Khanna SK and Justo CEG, Nemchand and Bros. Roorkee
3	" Highway Engineering " by Kadiyali L.R, , Khanna Publishers, New Delhi
4	" Traffic Engineering and Transport Planning " by Kadiyali L R
5	"Railway Engineering "by Satish Chandra and Agarwal M M, Oxford university press.
6	IRC Codal Provisions
7	Transportation Engineering and related courses in NPTEL , Swayam
8	Industry Consultation
9	Web searches

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS

Course Code- **L:T:P-**

Course Description:

This course provides polytechnic students with a foundational understanding of the entrepreneurial mindset, processes, and skills required to identify opportunities, develop innovative solutions, and create sustainable ventures. Throughout the semester, Critical Thinking, Excellent communicator (Good story teller), and Empathetic Leadership skills development for the students, through a blend of theoretical concepts, case studies, and practical exercises, students will learn to think like entrepreneurs, fostering creativity, problem-solving, and a proactive approach to career and economic development. The course emphasizes practical tools and methodologies applicable across various technical and vocational fields. This course will focus towards small Businesses including services and products

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Course Learning Outcomes (CLOs):

Upon successful completion of this course, students will be able to:

1. **Define and explain** core concepts of entrepreneurship, innovation, and small business management.
2. **Identify and evaluate** entrepreneurial opportunities using various ideation and market research techniques.
3. **Develop a basic business model** using tools like the Business Model Canvas.
4. **Understand fundamental aspects** of market analysis, competitive landscape, and target customer identification.
5. **Articulate key considerations** in managing startup finances, legal structures, and intellectual property.
6. **Develop and deliver a compelling pitch** for a new business idea.
7. **Cultivate an entrepreneurial mindset**, including adaptability, resilience, and a willingness to take calculated risks.

Course Content Outline (Weekly Breakdown):

Unit 1: Understanding Entrepreneurship and the Entrepreneurial Mindset (Weeks 1-2)

- **Week 1: What is Entrepreneurship? The Journey Begins.**
  - Definition of entrepreneurship, innovation, and intrapreneurship.
  - Dispelling myths about entrepreneurs.
  - The role of entrepreneurship in economic development and job creation (local and global context).
  - Types of entrepreneurships: lifestyle, scalable, social, tech, side-hustle.
  - Introduction to JUT's entrepreneurial ecosystem and local success stories
  - ***Activity:*** **Ice-breaker: "What problem bothers you the most in your daily life/local community?"**
- **Week 2: The Entrepreneurial Mindset & Traits of Successful Entrepreneurs.**

- Key entrepreneurial characteristics: passion, resilience, adaptability, creativity, risk-taking (calculated), problem-solving.
- Growth mindset vs. fixed mindset.
- Identifying personal strengths and weaknesses as potential entrepreneurs.
- Importance of networking and mentorship.
- *Case Study:* Analyze a local polytechnic graduate who started a successful business.
- ***Activity:*** **Self-assessment quiz: "Are you ready for entrepreneurship?"**

Unit 2: Opportunity Identification & Ideation (Weeks 3-4)

- **Week 3: Finding Your Big Idea: Problem-Solving Approach.**
  - Sources of entrepreneurial opportunities: pain points, market gaps, trends, technological advancements, personal hobbies/skills.
  - Design Thinking principles for problem identification.
  - Techniques for observing and understanding customer needs (empathy mapping).
  - ***Activity:*** **Field observation exercise: Identify 3 problems in a chosen environment (e.g., campus, local market).**
- **Week 4: Ideation & Validation Techniques.**
  - Brainstorming methods: SCAMPER, S- Substitute, C-Combine, A- Adapt, M-Modify, P- Put to another Use, E-Eliminate, R- Reverse/Rearrange (Mind Mapping, Reverse Brainstorming)
  - Concept generation and prototyping
  - Introduction to Minimum Viable Product (MVP) concept.
  - Initial idea validation: informal surveys, interviews with potential customers.
  - ***Activity:*** **Group ideation session for a chosen problem; develop a basic MVP concept.**

Unit 3: Business Model Fundamentals (Weeks 5-6)

- **Week 5: Introduction to the Business Model Canvas (BMC).**
  - Understanding the nine building blocks of the BMC: Customer Segments, Value Propositions, Channels, Customer Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships, Cost Structure.
  - How the BMC provides a holistic view of a business.
  - *Activity:* Analyze the BMC of a well-known local or global company.
- **Week 6: Developing Your Value Proposition & Customer Segments.**
  - Deep dive into Value Proposition Design: understanding customer jobs, pains, and gains.
  - Defining your ideal customer segments: demographics, psychographics, behaviors.
  - Niche markets vs. broad markets.
  - ***Activity:*** **Students start populating the Customer Segments and Value Propositions blocks of their own business idea's BMC.**

Unit 4: Market Analysis & Strategy (Weeks 7-8)

- **Week 7: Market Research Essentials.**
  - Importance of market research: primary vs. secondary research.
  - Basic tools for market research: online surveys (e.g., Google Forms), competitor analysis, industry reports.
  - Analyzing market size, trends, and growth potential.

    - ***Activity:*** **Conduct preliminary secondary market research for their chosen industry.**
- **Week 8: Understanding Your Competition & Marketing Basics.**
    - Competitor analysis: identifying direct and indirect competitors, SWOT analysis (Strength, Weakness, Opportunity, Threat).
    - Developing a competitive advantage.
    - Introduction to the Marketing Mix (4 Ps: Product, Price, Place, Promotion) in a startup context.
    - Branding basics for new ventures.
    - *Guest Speaker (Optional):* Local entrepreneur sharing marketing strategies.

Unit 5: Financial, Legal & Operational Foundations (Weeks 9-11)

- **Week 9: Startup Financial Basics.**
    - Understanding startup costs (fixed vs. variable).
    - Revenue models: how businesses make money.
    - Basic concepts of pricing strategies.
    - Sources of funding: bootstrapping, FFF (Friends, Family, Bootstrap), grants, basic loans, angel investors (brief overview).
    - ***Activity:*** **Calculate initial startup costs for their business idea.**
- **Week 10: Legal & Regulatory Aspects for Startups.**
    - Choosing a business structure: Sole Proprietorship, Partnership, LLC (simple overview, focus on local context).
    - Importance of business registration and licensing.
    - Basic understanding of contracts and agreements.
    - Introduction to Intellectual Property (IP): patents, trademarks, copyrights (relevance to polytechnic innovations).
    - *Guest Speaker (Optional):* Small business lawyer or a representative from a local business registration office.
- **Week 11: Operations & Team Building.**
    - Key operational considerations: supply chain, production/service delivery, quality control.
    - Building an effective founding team: complementary skills, roles, and responsibilities.
    - Importance of company culture in a startup.
    - ***Activity:*** **Define key activities and key partners for their BMC.**

Unit 6: Pitching, Growth, and Next Steps (Weeks 12-14)

- **Week 12: Crafting Your Pitch & Storytelling.**
    - Purpose of a pitch deck.
    - Components of a compelling pitch: problem, solution, market, team, business model, ask.
    - Storytelling techniques for engaging an audience.
    - Verbal and non-verbal communication skills.
    - *Activity:* Students draft their initial pitch script.
- **Week 13: Developing Your Business Plan (Lean Approach) & Refining Your Pitch.**
    - Overview of a lean business plan (as opposed to a traditional, lengthy one).
    - Refining the Business Model Canvas into a more comprehensive plan.
    - Peer feedback session on draft pitches.
    - ***Workshop:*** **Pitch practice session.**
- **Week 14: Final Pitch Presentations & Future Directions.**

- **Final Project:** Students present their business idea pitch (could be 5-7 minutes with Q&A).
- Discussion on continuous learning, adaptation, and potential next steps for their entrepreneurial journey.
- Resources available for aspiring entrepreneurs at JUT and in the local community.
- *Activity:* Course wrap-up and Q&A.

Assessment Methods:

To ensure a balance between theoretical understanding and practical application, the assessment for this course could include:

- **Participation & Engagement (10-15%):** Active involvement in discussions, group activities, and case study analyses.
- **Module Activities/Quizzes (20-25%):** Short quizzes, completion of assigned BMC sections, market research exercises, ideation assignments.
- **Individual/Group Assignments (30-35%):**
  - **Mid-Term Assignment:** Developed Business Model Canvas for their chosen idea (could be individual or small groups).
  - **Research Report:** A brief report on their market research and competitive analysis.
- **Final Project (30-35%):**
  - **Business Pitch Deck:** A professional-looking presentation outlining their business idea.
  - **Oral Pitch Presentation:** Delivering a concise and compelling pitch to the class (and potentially invited faculty/local entrepreneurs).

Recommended Resources & Tools:

- **Primary Textbook**
- **Online Platforms/Tools: Introduction to Entrepreneurship Dr Prakah Kumar, Raj Jaswa, Ramesh Yadava**
  - Google Workspace (Docs, Sheets, Slides, Forms) for collaboration and surveys. Canva for creating visual aids and pitch decks. URL **https://www.canva.com/**
  - **web.showreelapp.com** Sabeer Bhatia
  - Online market research tools (e.g., Statista, government statistical websites, industry association sites).
  - Whiteboards, sticky notes, and markers for brainstorming sessions.
- **Guest Speakers:** Local entrepreneurs, business development agencies, IP lawyers, startup mentors.
- **Case Studies:** A mix of successful and failed startups, particularly those relevant to polytechnic fields (e.g., tech, engineering, design, trades).

POFESSIONAL ELECTIVE

STEEL STRUCTURES

Course Code:- **L:T:P-**

Pre requisites

This course requires the knowledge of subjects Engineering Mechanics, Strength of Materials and Material testing laboratory

Course Outcomes

Upon the completion of the course, the student shall be able to

CO1	Illustrate the basic concepts of limit state design and suitability of different types ofstandard rolled steel sections
CO2	Analyse and Design a suitable connection based upon the conditions according to standards
CO3	Design the tension members considering the various failure patterns as per codal provisions.
CO4	Design suitable compression member and a slab base for the given conditions as per code
CO5	Design and analysis of suitable laterally restrained beam as per code
CO6	Plan a suitable roof truss for the given span as per standards and Calculate the loads acting on the truss using relevant Indian Standards

Course Content

UNIT-1: Introduction and fundamentals of limit state design of steel structures

Duration: 08 Periods (L: 6 – T: 2)

a. Merits and demerits of steel structures.
b. Loads considered in the design of steel structures as per I.S:875 -2015.
c. Introduction to I.S. 800-2007
d. Physical and Mechanical properties of structural steel
e. Standard structural sections as per SP-6, part-1
f. Classification of cross sections – class 1(plastic), class2(compact), class3(semi compact) and class4(slender).
g. Concept of Limit State Design – limit state of strength – limit state of serviceability –classification of actions – strength – partial safety factors for loads and materials.

UNIT-2: Design of Bolted and Welded Connections Duration: 15 Periods (L: 13 – T:2)

a. Different types of joints

b. Different types of Connections

c. Difference between bolted joints and welded joints.

d. Advantages and disadvantages of bolted connections.

e. Types of bolts, grades of bolts, difference between unfinished bolts and High strength friction grip bolts (HSFG).

f. Behavior of bolted joints, failure of bolted joints

g. Design Strength and Efficiency of lap joint and butt joint with chain pattern for bearing type bolts only.

h. Advantages and disadvantages of welded joints.

i. Different forms of welded joints.

j. Fillet welded joint – detailed sketch showing the component parts.

k. Stresses in welds as per I.S.800-2007 – Codal requirements of welds and welding.

l. Problems on calculation of design strength of a fillet welded joint.

m. Design of fillet welded joint for a plate to resist the given load.

n. Design of fillet welded joint for single angle carrying axial loads.

UNIT-3: Design of Tension Members **Duration: 12 Periods (L:10– T:2)**

a. Introduction to tension members.

b. Different forms of tension members and their behavior.

c. Different modes of failures – gross section yielding, net Section rupture and block shearfailure.

d. Maximum values of effective slenderness ratios as per code.

e. Calculation of net effective sectional area of single angle with bolted and welded connection.

f. Calculation of the design strength due to yielding of gross section, rupture of critical section and block shear – problems on plate and single angle section connected with bolts and welding.

g. Design procedure of tension members.

h. Problems on design of tension members using plates and single angle with bolted and welded connections.

UNIT-4: Design of Compression Members

Duration: 15 Periods (L: 12 – T: 3)

a. Introduction to compression members.

b. Different forms of compression members and their behaviour.
Effective lengths for different end conditions – Table 11 of I.S:800.

c. Buckling class of cross section – imperfection factor and stress reduction factor fordifferent buckling classes

d. Maximum values of effective slenderness ratio as per code

e. Calculation of design strength of compression members – problems (I-sections only)

f. Design of compression members – problems on simple I-sections only (no built-up sections).

g. Codal provisions for angle struts – Design of single angle struts with welded connection only

h. Codal provisions for Lacing and Battens of built-up columns as per code.

i. Column bases-types, Design of slab base along with cement concrete square pedestal – problems.

UNIT-5: Design of Beams

Duration: 14 Periods (L:12– T:2)

a. Concept of limit state design of beams – Classification of beams based upon lateral restraint of compression flange.

b. Types of failures of laterally supported and laterally unsupported beams.

c. Design strength of Laterally supported beam (simply supported and cantilever) considering bending and shear.

d. Design of laterally supported beam - simply supported under symmetrical point loads and udl acting throughout the span, cantilever under point load at free end and udl throughout the span, considering all codal requirements. Check for bending, shear and deflection.

e. Web Buckling and Web crippling- concept (no problems)

f. Shape factor–Problems on Calculation of shape factor for symmetrical sections (rectangular, circular, I-sections only).

g. Component parts of plate girder with sketches – different types of stiffener plates.

UNIT-6: Design of Roof Trusses **Duration: 11 Periods (L:9 – T:2)**

a. Types of trusses – plane trusses, space trusses.

b. Sketches of different roof trusses with their suitability for a given span.

c. Cross sections of truss members.

d. Loads on roof trusses as per I.S – 875-2015.

e. Determination of loads at various nodal points of a given roof truss due to dead

load, live load and wind load, considering the coefficients K1, K2, K3, K4, design wind speed, design wind pressure, external and Internal pressure coefficients. – problems.

Reference Books

1. Steel Structures Design & Practice by N.Subramanian, oxford University Press
2. Code of practice: IS 800-2007
3. Limit state Design of Steel Structures by S.K. Duggal/TMH
4. Structural steel design by M.L.Gambhir/TMH
5. Design of Steel Structures by S.S.Bhavikatti
6. Structural Engineering by A.P.Arul Manickam
7. Shah.V.L. and Veena Gore, "Limit State Design of Steel Structures", IS 800–2007 StructuresPublications, 2009.
8. Teaching Resource Material :http://www.steel-insdag.org
9. Teaching Resource Material :http://www.nptel.iitm.ac.in

Suggested E-learning references

1. http://nptel.ac.in/courses/105106112/
2. https://www.youtube.com/watch?v=EFBTSKPW5Ek
3. https://www.youtube.com/watch?v=C4Mm3mvN1P0

WATER RESOURCE ENGINEERING

Course Code- L:T:P-

I. RATIONALE

Water is essential resource for all the living thing on earth, making its conservation crucial. With increasing demand and unpredictable rainfall in India, efficient water management system is more important than ever. Irrigation structures like dams, diversion head works, and canals play a key role in this effort. Water Resource Engineering deals in the planning, designing, constructing, and executing these hydraulic structures which are used to used to store, distribute and conserve the water sources. The primary goal of water resources engineering is to control and regulate water for various purposes including flood control, irrigation, hydroelectric power development etc. This course will enable the students to use and apply the basic principles and practices related to irrigation engineering and utilization of supplied water at field.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Suggest the relevant irrigation systems for the given site conditions.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Evaluate the hydrological parameters of the given site.
CO2 - Compute the Canal capacity for the crop water requirement of the given command area. CO3 - Suggest the suitable type of dam for the given site condition.
CO4 - Execute the Minor and Micro Irrigation Schemes.
CO5 - Propose the type of Diversion Headwork in the irrigation scheme.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Unit	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Hours
1	**Unit - I Introduction to Irrigation and Hydrology** 1.1 Irrigation: Definition, necessity and Classification of Irrigation projects, advantages and ill effects of excess irrigation. 1.2 Hydrology: Definition of Hydrological cycle, Rainfall, Evaporation. 1.3 Rain Gauge: Symon's rain gauge and automatic rain gauge - Tipping bucket type. 1.4 Methods of calculating mean rainfall: Arithmetic mean, Theissen polygon and Isohyetal method. 1.5 Runoff: Definition, factors affecting Runoff (No Numerical questions). 1.6 Maximum Flood Discharge measurement: Empirical methods.	

Unit	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Unit
2	**Unit - II Crop water requirement and Reservoir Planning** 2.1 Crop Water requirement: Cropping seasons, Crop period, Duty, Delta, base period, Culturable Command Area, Gross Command Area, intensity of irrigation, factors affecting duty. 2.2 Relation between duty, delta and base period. 2.3 Numerical on water requirement and capacity of canal. IKS: Rahat water Irrigation system in India. 2.4 Methods of Irrigation: Surface, subsurface and overhead irrigation. 2.5 Silting of Reservoir: Rate of silting, factors affecting silting and control measures. 2.6 Control levels in reservoir. Numerical on fixing control levels of reservoir.	
3	**Unit - III Dams and Spillways** 3.1 Dam and its classification based on use, materials and hydraulic design. 3.2 Earthen Dams: Components with function, typical cross section. 3.3 Methods of construction of earthen dam, seepage through embankment and foundation and its control, Types of failure of earthen dam and its preventive measures. 3.4 Gravity Dams: Forces acting on dam, typical cross section, drainage gallery. 3.5 Spillways: Definition, function, Types. Emergency and service spillway - ogee spillway and discharge over spillway, Spillway gates . 3.6 Energy dissipation.	
4	**Unit - IV Minor and Micro Irrigation** 4.1 Bandhara irrigation: Introduction, Layout, components, construction. 4.2 Percolation Tanks: Selection of site, need, construction. 4.3 Lift irrigation scheme: Components and their functions, layout. 4.4 Drip and Sprinkler Irrigation: components, layout, suitability. 4.5 Well irrigation: Introduction, types, advantages and disadvantages.	

Unit	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Hours
5	**Unit - V Diversion Headwork and Canals** 5.1 Weirs: Introduction, components, classification. K.T. weir : components and construction. 5.2 Barrages : Introduction, components and their functions, location. 5.3 Diversion headwork : Layout, components and their function. 5.4 Canals: Definition, classification according to alignment and position in the canal network, cross section of canal in embankment and cutting, partial embankment and cutting. 5.5 Canal lining: Purpose, construction material used, advantages. 5.6 Cross Drainage works: Aqueduct, siphon aqueduct, super passage, level crossing. 5.7 Canal regulators: Head regulator, Cross regulator, escape, falls and outlets.	

V. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
	Punmia, B.C., Pande B, Lal	Irrigation and water power Engineering	Lakshmi Publications, New Delhi - 110 002. Edition2016 ISBN 13: 9788131807637
2	Sharma R.K. and Sharma T.K	Irrigation Engineering	S.Chand and Company Ltd.Delhi ISBN 13: 9788121921282 Ed.2002
3	Basak N.N.	Irrigation Engineering	McGraw Hill Education India Pvt. Ltd. New Delhi.Edition1999 ISBN 13: 9780074635384
4	Dahigaonkar J.G.	Irrigation Engineering	Asian Book Pvt. Ltd., New Delhi ISBN 13: 9788184120080
5	S.K.Garg	Irrigation and Hydraulic structures	Khanna Publishers, Delhi. ISBN: 978-81-7409-047-9

VI. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://wrd.maharashtra.gov.in/	Water resource department, government of Maharashtra, India
2	https://archive.nptel.ac.in/courses/126/105/126105010/	Introduction to Irrigation Engineering and Hydrology
3	https://www.youtube.com/watch?v=fx1uUek3Iqg	Hydrological cycle and Methods of computing Average rainfall
4	https://nptel.ac.in/courses/105105110	Surface & ground water resources
5	https://www.youtube.com/results?search_query=crop+water+requirement	Crop water requirement
6	https://archive.nptel.ac.in/courses/126/105/126105010/	Crop water requirement
7	https://www.youtube.com/watch?v=bDwow2-WzHo	Introduction to Dams
8	https://archive.nptel.ac.in/courses/105/105/105105110/	Notes on Gravity Dam

9	https://archive.nptel.ac.in/courses/105/105/105105110/	Notes on Spillways and Energy Dissipators
10	https://archive.nptel.ac.in/courses/126/105/126105019/	Micro irrigation engineering
11	https://archive.nptel.ac.in/courses/126/105/126105010/	Sprinkler irrigation and Drip Irrigation
12	https://archive.nptel.ac.in/courses/126/105/126105010/	Irrigation wells
13	https://www.youtube.com/watch?v=pEdY37n7CdE	Introduction to Canal
14	https://www.nitsri.ac.in/Department/Civil%20Engineering/CIV-604_IHS-6th_CIVIL-Chapter-5_Notes.pdf	Cross Drainage works
15	https://www.youtube.com/watch?v=Ps99Cs0RQJs	Canal design

INTEGRATED WASTE MNAGMENT

Course Code:- L:T:P-

Pre requisites

This subject requires basic knowledge of Sanitary Engineering

Course Outcomes

Upon completion of the course, the student shall be able to

CO1	Identify the principles of safe disposal of solid waste
CO2	Explain the quality and recycling of municipal solid waste.
CO3	Analyze the components of integrated MSW handling system
CO4	Explain the laws on Management of biomedical solid waste.
CO5	Evaluate the importance and recycling of C& D waste
CO6	Illustrate the impacts of e-waste.

Course Contents

UNIT 1: Introduction to Solid Waste Manageme

Duration: 10 Periods(L:7 – T:3)

a) Definition of Solid waste

b) Classification of solid waste

c) Necessity of Solid waste disposal

d) Safe disposal of solid waste.

UNIT 2: Municipal Solid Waste Characteristics and Quantities

Duration:15Periods(L:11 – T:4)

a) Composition of MSW.
b) Quantity of generated MSW
c) Collection and Transportation of Municipal solid waste.
d) Separation for recycling and reuse of plastics, paper and glass from the MSW.

UNIT 2: Disposal of Municipal Solid Waste

Duration:15 Periods (L:8.5 – T:3.5)

a) Disposal of MSW.
b) Disposal of MSW by Sanitary Land filling method.
c) Land sealants for the control of gas and Leachate movement.
d) Disposal of MSW by Shredding and Pulverisation.
e) Disposal of MSW by Composting.
f) Disposal of MSW by barging it out into Sea.

UNIT 4: Biochemical process and Composting

Duration: 13 Periods(L:9.5 – T:3.5)

a) Biomedical wastes and their impacts on Health and Environment.
b) Legislative laws on Management of Biomedical wastes in India.
c) Collection, transportation and treatment of Biomedical wastes.
d) Disposal of Biomedical waste.
e) Human Resources issues on biomedical wastes

UNIT 5: Construction and Demolition (C&D)Waste Management

Duration: 13 Periods(L:9.5 – T:3.5)

a) C&D Definition, applicability and waste generating activities.
b) Estimation of C&D waste generation for India.
c) Initiatives to promote recycling of C & D waste in India
d) Importance of recycling C & D Wastes.
e) C&D Waste processing
f) The rules promote C&D Waste utilization.

UNIT 6: Electronic Waste (E-Waste) Management

Duration: 12 Periods(L:8.5 – T:3.5)

a) Definition of E- Waste.

b) Classification of E- Waste.

c) Adverse health and environmental impacts of E-Waste on its improper disposal.

d) Environmental and Occupational Hazards posed by disposal of certain categories of E- Waste.

e) Menace of E- Waste in India

Reference Book:-

1. Sewage Disposal by S.K. Garg.
2. Municipal Solid waste management by P Jayarami Reddy
3. C&D Waste Management Rules 2016.
4. NPTEL
5.

Suggested E-learning references

1. http://nptel.ac.in

Suggested Student Activities

1) To submit a report to implement a plan to reduce solid waste at your house/ college.

2) To submit a report on the life cycle of a CD/mobile /Calculator etc and prepare a fact sheet on findings in class in the form of Paper/Poster presentation.

3) Field trip to nearest MSW handling facility

4) Visit to any NGO/Public Health Department dealing with the environmental health program

5) Team work for analyzing the need for recycling

6) Prepare an excel sheet on sources of solid waste in a village/ town in teams.

7) Group discussion

8) Surprise Test

GEO TECHNICAL ENGINEERING

Course Code- L:T:P-

I. RATIONALE

The stability of any structure depends upon behavior of soil and bearing capacity of soil to carry loads under different loading conditions. Thus, the geotechnical engineering enables the decision maker to predict the behavior of soil under different loading conditions and also to determine the probable settlement arising from the construction activities. This course therefore will develop the basic understanding among the students to ensure the safety, stability, and long-term quality in the wide range of civil engineering projects such as buildings, dams, towers, embankments, roads, railways, retaining walls, bridges, underground tank and underwater structures.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Evaluate various soil properties required for design of foundation.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Apply the basic knowledge of Geology and Geotechnical Engineering in given situation
CO2 - Measure the physical properties of given soil sample
CO3 - Determine the shear strength of given soil sample
CO4 - Use the relevant method of compaction to determine parameters of given soil sample
CO5 - Undertake the relevant soil investigation techniques to determine the bearing capacity of the given soil strata

IV.COURSE CONTENT

Unit	Course Content	Hours
1	**Unit - I Overview of geology and geotechnical engineering** 1.1 Introduction to Geology: Branches, importance of geology, composition of earth. 1.2 Petrology: Definition of a rock, classification based on their genesis (mode of origin), formation, classification and engineering uses of igneous, sedimentary and metamorphic rocks. (IKS*: Sun temple of Konark made up of Chlorite, Laterite, Khondalite stones) 1.3 IS definition of soil, Importance of soil in Civil Engineering as construction material for foundation bed of structures. 1.4 Field applications of geotechnical engineering for foundation design, pavement design, design of earth retaining structures, design of earthen dam.	

Unit	Course Content	Hours
2	**Unit - II Physical and Index Properties of Soil** 2.1 Physical Properties: Soil as a three phase system, water content, void ratio, porosity and degree of saturation, density index, unit weight of soil mass; bulk unit weight, dry unit weight, unit weight of solids, saturated unit weight, submerged unit weight, specific gravity 2.2 Determination of Index Properties of Soil: determination of water content by oven drying method as per IS code, determination of bulk unit weight and dry unit weight by core cutter method and sand replacement method as per IS code, determination of specific gravity by pycnometer. 2.3 Particle size distribution, mechanical sieve analysis as per IS code, particle size distribution curve, effective diameter of soil, Uniformity coefficient and coefficient of curvature, well graded and uniformly graded soils, particle size. classification of soils, I.S. classification of soil. 2.4 Consistency of soil: Stages of consistency, Atterberg's limits of consistency viz. Liquid limit, plastic limit and shrinkage limit, plasticity index, determination of liquid limit, plastic limit	
3	**Unit - III Permeability and Shear Strength of Soil** 3.1 Definition of permeability, Darcy's law of permeability, coefficient of permeability, factors affecting permeability, determination of coefficient of permeability by constant head and falling head permeability tests, simple problems to determine coefficient of permeability. 3.2 Seepage through earthen structures, seepage velocity, seepage pressure, phreatic line, flow lines, application of flow net, (No numerical problems.) 3.3 Shear failure of soil, field situation of shear failure, concept of shear strength of soil, components of shearing resistance of soil – cohesion, internal friction. Mohr-coulomb failure theory, Strength envelope, strength Equation for purely cohesive and cohesion less soils. 3.4 Laboratory methods: Direct shear test, vane shear test (Numerical on direct shear test only)	

Unit	Course Content	Hours
4	**Unit - IV Compaction and Stabilization of soil** 4.1 Concept of compaction, purpose of compaction, field situations where compaction is required, Standard proctor test – test procedure as per IS code, Compaction curve, optimum moisture content, maximum dry density, Zero air voids line, Modified proctor test, factors affecting compaction, field methods of compaction : rolling, ramming and vibration, concept of consolidation, difference between compaction and consolidation. 4.2 Concept of soil stabilization, necessity of soil stabilization 4.3 California bearing ratio, C.B.R. test, interpretation of C.B.R. values. 4.4 Definition of earth pressure, lateral earth pressure at rest, active earth pressure and passive earth pressure with no surcharge condition, coefficient of earth pressure, Rankine's theory and its assumptions.	
5	**Unit - V Site Investigation and Bearing Capacity of Soil** 5.1 Site Investigation: Necessity of site investigation and sub-soil exploration, types of exploration, criteria for deciding the location and number of test pits and bores. Field identification of soil: dry strength test, dilatancy test and toughness test, Determination of free swell index. 5.2 Bearing capacity: Definition of bearing capacity, ultimate bearing capacity, safe bearing capacity and allowable bearing pressure, Introduction to Terzaghi's analysis and its assumptions (No Numerical). Types of failures in soil: general, local and punching shear failure, effect of water table on bearing capacity. 5.3 Field methods for determination of bearing capacity – Plate load test and standard penetration test. Test procedures as Per IS: 1888 & IS:2131	

SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Punmia, B.C.	Soil Mechanics and Foundation Engineering	Laxmi Publication (P) ltd., New Delhi, ISBN 9788170087915
2	Murthy, V.N.S.	A text book of soil mechanics and foundation Engineering	CBS Publishers & Distributors Pvt. Ltd., New Delhi 2016 ISBN: 9788123913629
3	Ramamurthy, T.N. & Sitharam,T.G.	Geotechnical Engineering (Soil Mechanics)	S Chand and Company LTD., New Delhi, ISBN: 9788121924573
4	Braja M. Das	Principles of Geotechnical Engineering	Cengage Learning ISBN: 9789355738103
5	Parbin Singh	Engineering And General Geology	S K Kataria and Sons ISBN-13 978-8188458516

LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/N2J-tvEeI4c?si=SgQPoICSbFAuOVLd	Determination of Water Content of Soil by Oven Drying Method
2	https://youtu.be/l6vk0EM4yPg?si=-M6WwrpxOlZYHy94	Determination of Specific Gravity of soil
3	https://youtu.be/5rDHjZ_RJq0?si=V714qwz1vE8f5pSP	Determination of Dry Density of Soil by Core Cutter Method
4	https://youtu.be/YejCi5SEOAU?si=n8w1uAauI7ZgaG9P	Determination of Dry Density of Soil by Sand Replacement Method

5	https://youtu.be/pM-w_cvk1nA?si=3evWNLPjtwFxtsP0	Determination of Liquid Limit and Plastic Limit of Soil
6	https://youtu.be/bmpn5oNDvOs?si=LxcoQUSe_lmL3QQ1	Direct Shear Test
7	https://youtu.be/CAezS3mPzOc?si=9-bIMPqTKy1MuPDG	Grain Size Analysis of Soil
8	https://youtu.be/c4i_y6u-tsE?si=BjcItf55LqNn2Ihn	Water Content Dry Density Relation Using Light Compaction OMC and MDD
9	https://youtu.be/fCmMW73rP64?si=mdAiq1WPkpc9n1Dl	California Bearing Ratio (CBR) value test
10	https://youtu.be/Lrml0egYtM4?si=ag1mezmk74UAuyCf	Determination of swelling properties (Free Swell Index of Soil)
11	https://smfe-iiith.vlabs.ac.in/List%20of%20experiments.html	Virtual laboratory practical for Soil Mechanics.
12	https://youtu.be/8Q8CZW9-jXE?si=8Yrf2NvS9b5v9kcF	A Soil Investigation Work (Borehole Drilling: SPT & Rock Coring)
13	https://www.ijsrp.org/research-paper-0121/ijsrp-p10935.pdf	The Architectural Study of Sun Temples in India: Based on Location, Construction Material and Spatial Analysis Study
14	https://youtu.be/QuE4tEK-5iY?si=t61uZOWhS_nd5z8H	Shallow Foundation: Plate Load Test
15	https://youtu.be/DjWDOqQjsyQ?si=k43rXl2I19YK9msV	How to conduct SPT / Standard Penetration Test/ Soil Exploration Technique/ Site Investigation

CONSTRUCTION MANAGEMENT & SAFETY

Course Content- L:T:P-

I. RATIONALE

The construction industry is in continuous need of skilled professionals, capable of managing projects efficiently in the capacity of project engineers, construction managers, site supervisors, and project coordinators, among others. It is required for a civil engineer to plan, manage and execute Civil Engineering works with utmost precision within the time frame so as to optimize the resources. Therefore, it is necessary to develop a perfect blend of knowledge, skills, and attitudes in the form of the competencies among the learners to tackle with such engineering projects effectively and efficiently leading towards sustainable development. This course will help in developing these basic competencies among the students which will enable them to get an employment in the market.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Manage the given construction project using the relevant techniques of construction management.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Conduct the project feasibility analysis of the given project.
CO2 - Apply the relevant scheduling technique in the given situation to decide the ethical element of the project.
CO3 - Manage the inventory using relevant inventory control techniques.
CO4 - Execute the project as per the prevailing safety practices

IV. COURSE CONTENT

Unit	Course Content	Hours

1	**Unit - I Project Initiation and its feasibility** 1.1 Project: Basic Definitions, management functions, ethics, project life cycle- Project Initiation, Project Planning, Project Executing, Project Monitoring and Controlling, Project Closing. 1.2 Project Characteristics and Constraints- Scope, time, cost, Quality; Stakeholder. 1.3 Project Feasibility Analysis- Market analysis, Financial analysis- Net Present Value(NPV), Payback Period, Examine the business problem/opportunity, Identify the requirements, undertake a feasibility study, Rank the feasibility results- Define the criteria, give ranking scores, Identify the feasibility outcome. 1.4 Project Management Frameworks and Standards, Project Management consultant (PMC)- roles & responsibilities. 1.5 Equipment used in executing the Civil Engineering projects- •Earth moving equipment (Tractor, Bulldozer, Scrapers, Excavators), • Hauling Equipment (Drum trucks, Front end loader, Conveyor belt), • Concreting Equipment (RMC mixer, Concrete pump), • Hoisting Equipment (Lifting & lowering equipments, Cranes).	

Unit	Course Content	Hours
2	**Unit - II Project Management and Scheduling** 2.1 Broad activities in construction work – Earthwork, Foundation, RCC Work, Brick work, Scaffolding, Plastering, Painting etc & duration required for complete the activity 2.2 Methods of Scheduling-Gantt Chart, Bar chart, Development of Bar charts and Gantt chart, Merits & limitations of Bar chart & Gantt chart. 2.3 Concept of CPM & PERT: Introduction to Critical path method (CPM), Program evaluation & review techniques (PERT), Network Diagramming of Projects Activity-on- arrow (AOA) Diagrams- Concept of Activity and Event, Time-Analysis of Networks- Forward Pass, Backward Pass, Probabilistic Durations- Optimistic Time, Pessimistic Time, Most Likely Time, Project Scheduling- ES and LS Schedules as Limits, Resource Scheduling, Time/Cost Trade-off	
3	**Unit - III Material Management** 3.1 Material Management-Introduction, Inventory and inventory control, EOQ (Economic order of quantity), ABC technique, V-E-D analysis, Just in Time Strategy (JIT), Store management & various records related to store management 3.2 Rebar Management: Wastage of steel on site, Preventive measures to avoid the wastage of steel. Rebar, Importance of rebar, Fabrication and transportation of Rebar. Understanding rebar drawings.	
4	**Unit - IV Safety and labour laws in construction** 4.1 Importance of Safety in construction work, causes of accidents on construction site & remedial measures, precautions to avoid accidents at site, safety policies. 4.2 Introduction to Labour laws related to construction- Workman Compensation Act, Minimum Wages Act, The Building and Other Construction Workers' (Regulation of Employment and Conditions of Service) Act, Janshree Vima Yojna	

SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	S.C. Sharma, S.V. Deodhar	Construction Engineering and Management	Khanna Book Publishing Co (P) Ltd. ISBN 9789386173980
2	IGNOU	Project Management	Indira Gandhi National Open University(eKumbh-AICTE)
3	K. K. Chitkara	Construction Project Management-Planning, Scheduling & Controlling	McGraw Hill Education ISBN-10 0070680752, ISBN-13 978-0070680753
4	L. S. Srinath	PERT And CPM Principles And Applications	East-West Press (Pvt.) Ltd. ISBN-10 8185336202 ISBN-13 978-8185336206
5	Jack Gido, Jim Clements, Rose Baker	Successful Project Management	Cengage Publication ISBN: 9781337363853

LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/105/103/105103206/	Construction Method and Equipment Management
2	https://www.youtube.com/watch?v=Cx7i2wXB0kA&list=PLWnoy5z_3BObBvFtBlowxM05D-q0VAWEs&index=16	Project Scheduling
3	https://www.youtube.com/watch?v=j6VIllXT0Vs&list=PLWnoy5z_3BObBvFtBlowxM05D-q0VAWEs&index=22	Accidents in Construction Industry
4	https://www.youtube.com/watch?v=EVsi1QamfU0&list=PLWnoy5z_3BObBvFtBlowxM05D-q0VAWEs&index=26	Safety Organization and Safety Officer
5	https://www.youtube.com/watch?v=QoXvRBrFWyI&list=PLWnoy5z_3BObBvFtBlowxM05D-q0VAWEs&index=25	Implications of Construction Accidents
6	https://archive.nptel.ac.in/courses/105/104/105104161/	Introduction to planning and scheduling, resource levelling and allocation,crashing of networks
7	http://www.cidc.in/	Construction Industry Development Council (CIDC)
8	https://onlinecourses.nptel.ac.in/noc22_ce39/preview	Safety in Construction Industry
9	https://www.youtube.com/watch?v=Tm2HhqMu5Jg	PERT and CPM
10	https://www.youtube.com/watch?v=GAGoqqZSPh4&list=PLWnoy5z_3BObBvFtBlowxM05D-q0VAWEs&index=3	Overview of steps in execution of a project
11	https://www.youtube.com/watch?v=kuCHsNXeNMc&list=PLWnoy5z_3BObBvFtBlowxM05D-q0VAWEs&index=5	Resource Management in Construction Projects
12	https://www.youtube.com/watch?v=Bh_LYZh3KH4&list=PLWnoy5z_3BObBvFtBlowxM05D-q0VAWEs&index=21	Introduction to construction safety

PRE STRESSED CONCRETE

Course Content- L:T:P

I. RATIONALE

Precast and Pre-stressed Concrete construction technology is widely used across the world for its inherent advantages. It has been adopted in India from past many years, but was mostly limited to civil structures such as tunnels, bridges, flyovers and underpasses. Today, with critical housing shortages, rising labour and input costs and an increased emphasis on quality and timely delivery, more and more developers are opting for innovative construction practices like precast and pre-stressed concrete. Hence it is essential to make upcoming engineering community aware about this. This course is designed to provide basic knowledge of precast and pre-stressed elements, their design aspects, pre-stressing techniques, methods and basic design principles.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Execute effectively the construction work involving precast and pre-stressed concrete

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Propose the relevant precast concrete element for a given situation

CO2 - Use the relevant components for the prefabricated structure.

CO3 - Justify the relevance of pre-stressed concrete in a given situation.

CO4 - Suggest the relevant methods / systems for given construction work.

CO5 - Evaluate losses in a given pre-stressed concrete construction and propose a suitable cable profile.

IV.COURSE CONTENT

Unit	Course Content	Hours
1	**Unit - I Precast concrete and its Elements** 1.1 Definition and necessity of precast, Advantages and disadvantages. Materials used. 1.2 Study of Structural Precast concrete elements such as fencing poles, transmission poles, paver blocks, doors and window frames, Manhole covers, precast Mesh etc. 1.3 Study of Precast Structural Building components such as slab panels, beams, columns, footings, walls, lintels and chajjas, staircase elements. 1.4 Non-structural precast concrete elements such as bridge panels, tunnel lining, cannel lining, piles, box culvert etc. 1.5 Materials required, IS specifications, casting tolerances, fabricating systems, joints, testing, storage and transportation, equipment's for elements such as PCC, RCC, PSC, SCC, Ferro-cement, Autoclaved Aerated Concrete (AAC) and Foam concrete. 1.6 Testing of Precast components.	

Unit	Course Content	Hours
2	**Unit - II Prefabricated Buildings** 2.1 Concept and Benefits of Prefabricated Construction, Prefabricated Construction Process. 2.2 Precast load bearing and non-load bearing wall panels, floor systems, Material characteristics, Plans & Standard specifications, concept of modules, modular co-ordination, modular grids and finishes. 2.3 Prefab systems and its classification, structural schemes. 2.4 Joints – requirements of structural joints and their design considerations for above elements. 2.5 Manufacturing, storage, curing, transportation and erection of above elements, equipment needed. 2.6 Introduction to Mixed and composite construction. 2.7 Ecological aspect of use of Prefabricated building.	
3	**Unit - III Fundamentals of Pre-stressed Concrete** 3.1 Concept of pre stressing and post tensioning, basic terminology. 3.2 Applications of pre-stressed concrete. 3.3 Advantages and disadvantages of pre-stressed concrete with respect to other construction material. 3.4 Materials used and their properties, Necessity of high- grade materials. Types of Special concrete/ High Strength concrete and requirements for precast and prestressed members 3.5 Types of Pre-stressing steel -Wire, Cable, tendon, Merits-demerits and applications.	
4	**Unit - IV Methods and Systems of pre- stressing** 4.1 Methods of pre-stressing : Internal and External pre- stressing, Pre and Post tensioning- applications, merits and demerits 4.2 Systems for pre tensioning: process, applications, merits and demerits - Hoyer system 4.3 Systems for post-tensioning - process, applications, merits and demerits - Freyssinet system, Magnel Blaton system, Gifford Udall system.	
5	**Unit - V Losses of pre-stress and Analysis of Pre- stressed rectangular beam section** 5.1 Pre-stressing force in Cable, Meaning of Loss of Pre- stress. 5.2 Loss of pre-stress during the tensioning process - loss due to friction, length effect, wobbling effect and curvature effect, Loss of pre-stress at the anchoring stage, Loss of pre-stress occurring subsequently: losses due to shrinkage of concrete, creep of concrete, elastic shortening, and creep in steel. 5.3 IS recommendations for % losses in case of Pre and Post tensioning. 5.4 Basic assumptions in analysis of pre-stressed concrete beams. 5.5 Cable Profile in simply supported rectangular beam section – concentric, eccentric straight and parabolic 5.6 Effect of cable profile on maximum stresses at mid span and at support. (No Numerical problems in theory examination)	

SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Marzuki , Nor Ashikin	Pre-Cast and Pre-Stress Technology: Process, Method and Future Technology	Create space Independent Publication ISBN 10: 1499353391 ISBN 13: 978-1499353396
2	Elliott, Kim S.	Precast Concrete Structures	CRC Press, New York, 2011 ISBN- 13: 9781498723992
3	Lin, T.Y.	Design Of Pre-stressed Concrete Structures	John Wiley and Sons, New York, 2014 ISBN-8: 0471018988
4	Krishna Raju, N.	Pre-stressed Concrete	Tata McGraw Hill, New Delhi, 2012 ISBN 10: 1259003361 ISBN 13: 9781259003363
5	Nagarajan, Pravin	Pre-stressed Concrete Structures	Pearson Education India ISBN 9332517614, 9789332517615

LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/WWm5S2L-VCI?si=30k3M9OWF0fyEqJk	Build a home in 8 weeks with Precast Concrete Homes.
2	https://youtu.be/nlgYwCQsoEs?si=Pexa85CsY9VEjBW3	Precast House
3	https://youtu.be/F-eiUHWN3-s?si=nB-fKEt7on-w2DLp	The Key Design Principles for Precast Concrete Design
4	https://youtu.be/hMwwPjKeHnc?si=7jieERxp6MoYWFpl	Watch How Precast Concrete Wall Panels are Installed for a House
5	https://youtu.be/2OUgqlzDIrw?si=GHRLAmm3VCr5UyrB	FOAM CONCRETE, affordable house built in 6 days!
6	https://youtu.be/blM396ZtCY4?si=0qnjs1mMQdO-0Vi6	hollow block making process in India, concrete hollow bricks, hollow bricks machine
7	https://youtu.be/h3N0vzU5VO8?si=oYLDfBWYQY0ShLxy	AAC Block Making Process
8	https://youtu.be/4KYPltsNAWs?si=Ak_QoFz20p4IIsVf	Lecture 1 - Prestressing System by NPTEL
9	https://youtu.be/4NelroYGY3U?si=vhPOEijKq-U_5QWk	Lecture-2-Type of Prestressing
10	https://youtu.be/aJfCAgeJ55I?si=7c-VEBxz0KmqsWr5	Lecture-3-Prestressing System and Devices (Pre-Tensioning) by NPTEL
11	https://youtu.be/9ROVbBANMUU?si=4VVbRi8vS4JxIuJO	Lecture-4-Prestressing System and Devices (Post-Tensioning) by NPTEL
12	https://youtu.be/MIvfc6xScMo?si=uRxbbFL269c8-9jS	Pre-Tensioning VS Post Tensioning
13	https://youtu.be/yOuk_DSuTb0?si=wdq-wbMZSmleCFBp	Prestressed Concrete
14	https://youtu.be/mfZo_HvMmM8?si=mP0Bqf7vRdnN7Xke	Prestressed Concrete - Unbonded Post-Tensioning

OPEN ELECTIVE

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Course Code- L:T:P

Introduction:

Welcome to the curriculum for the Artificial Intelligence and Machine Learning (AI&ML) Specialisation. This specialisation course is taught in Bootcamp mode. Bootcamps are 12 weeks, intense learning sessions designed to prepare you for the practical world – ready for either industry or becoming an entrepreneur. You will be assisted through the course, with development-based assessments to enable progressive learning. In this course, you'll learn how to produce a computer- assisted solution when data is too complex for humans to find answers as they combine both data science and machine learning skills that are needed for today's job market.

Some common examples include; Amazon Alexa - converting spoken audio into language; Google Image Search – uses image recognition to return specific search results; Samsung Smart Fridges – uses data and machine learning to produce intuitions about your behavior. Leading to the successful completion of this bootcamp, you shall be equipped to either do an internship at an organization working in AI or do a project in AI. After the completion of your Diploma, you shall be ready to take up roles like Machine Learning Engineer, Data Scientist, Data Analyst, and more.

This course will teach you Fundamentals of AI, Python and Python libraries, data visualization, machine learning models, maths like linear algebra, data interpretation, deep learning, Version control system, cloud deployment and more. Details of the curriculum is presented in the sections below.

Pre-requisite

Before the start of this specialisation course, you would have completed the following courses;

In the 1st year of study, you would have studied Engineering Mathematics, Communication Skills, Computer Aided Engineering Graphics, Statistics & Analysis, Basic IT Skills, Fundamentals of Computer, Fundamentals of Electrical and Electronics Engineering, Project Management skills and Multimedia & Animation.

In the 2nd year of study, you would have studied Python Programming, Computer Hardware, Maintenance and Administration, Computer Networks, Database System Concepts and PL/SQL, Data Structures with Python, Operating System and Administration, Object oriented programming and Design with Java, Software Engineering principles and practices.

In this year of study, you shall be applying your previous years learning along with specialised field of study into projects and real-world applications.

Course outcome: A student should be able to

CO1	**Explain the concept of AI, its applications, constituents and challenges of ethics in AI.**
CO2	**Analyze and visualize any given dataset**
CO3	**Evaluate, optimize, build and test an AI model for a given requirement**
CO4	**Perform comparative analysis of methods or algorithms for a given requirement**
CO5	**Select the appropriate tools, production environment and deploy the model.**

Detailed Course Content

Week	C O	P O	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	1	1	1	1. AI based movie (Screening)			4	- AI influence in companies viz, Amazon, Microsoft, Google, IBM - Latest developments in AI domain - Google's DeepMind AI Just Taught Itself To Walk - YouTube - Introducing Amazon Go and the world's most advanced shopping technology - YouTube - IBM Watson - Understanding the evolution of AI and HMI (human machine interface) - Discussion on how AI will Impact of daily life, work life, work force, jobs, products and services – T	2		1
	1	1	2	Fundamentals of AI - What is artificial intelligence? - How AI works - Purpose of AI - Types of Artificial Intelligence - Goals of AI - Applications of AI	3		1	- Significance of data in AI - AI Software Development life cycle - Compare traditional software development with AI Software Development - Example – Game rules (Chess) Explore and prepare a report on all popular AI cloud services (ML & DL) offered by vendors - T	2		1

				- Ethics in AI Examples of AI in real world - T							
	5	4,5	3	Why Do We Need a Version Control System? Fundamentals of Git Git installation and setup basic local Git operations ▪ creating a repository, ▪ cloning a repository, ▪ making and recording changes ▪ staging and committing changes, ▪ viewing the history of all the changes ▪ undoing changes	1		3	Git Branching and merging Basic ▪ Creating and switching to new branches ▪ Switching between branches ▪ Merging local branches together			3
	5	4,5	4	GitHub - Basics of distributed git - Account creation and configuration - Create and push to repositories - versioning - Collaboration - Migration	1		3	Create repository – named mini project-1 Push the same to GitHub TOC - Git Essentials: Become a Git and GitHub Ninja | Infosys Springboard (onwingspan.com)			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	1	**1,5**	6	Real industry experience of AI	2		3	Weekly Assignment(1PM-2PM)			
2	1	1	1	Peer Review		4		**Machine Learning**	2		1

								- Fundamentals - Machine learning types - Machine learning workflow - Machine learning applications - Challenges in ML - Building a model – steps involved - Pipelines ▪ Data engineering ▪ Machine learning ▪ Deployment - What is Data Science? - How Data Science works? - Data Science uses Group discussion - Examples of ML in everyday life / Use of Machine Learning in Daily Life Machine Leaning Terminologies - T TOC - Machine Learning Fundamentals | Infosys Springboard (onwingspan.com) Prediction – continuous value			
	1,5	1,4	2	Introduction to Cloud Computing - Essentials of Cloud Computing - Cloud Deployment Models - Cloud Service Models	2		2	Introduction to Containers Cloud Native application development Explore AI (ML and DL) services across public cloud platforms	1		2

				- Serverless Services - Major Cloud service Providers - Virtualization Explore the cloud service providers and services offered by them - T				Note : teacher has to choose a public cloud platform to perform the fallowing activities - Getting to know cloud platform - Creating an account			
	1,5	**4,5**	3	- Walking through the administrative console and Cloud SDK - Explore Virtual machines (PaaS, Iaas and SaaS) and storage options - Deploy a simple application on the cloud - AI Platform overview	1		3	Essentials of cloud billing SLA TOC - Essentials of Cloud Computing | Infosys Springboard (onwingspan.com) Tutorial - Automatically Create Machine Learning Models - Amazon Web Services Tutorial - Automatically Create Machine Learning Models - Amazon Web Services	1		2
	1	1,3 4	4	Big Data - What is Big Data? - Vs of Big Data - Sources of data - Role of Big Data in AI&ML Python Packages for Machine Learning and Deep Learning - Scientifics computing libraries - Visualization Libraries - Algorithmic libraries Environment setup: install required packages	1		3	Python recap Database connectivity	1		2

				Explore above listed packages							
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	1,5	**2,3 ,4**	6	Build applications using AI cloud services	2		3	Weekly Assignment			
3	**1,5**	**2,3 ,4**	1	Peer review		4		Explore NumPy Module - Array Aggregation Functions - Vectorized Operations - Use Map, Filter, Reduce and Lambda Functions with NumPy - TOC - Pandas and NumPy Tips, Tricks, and Techniques | Infosys Springboard (onwingspan.com)			3
	1,5	**2,3 ,4**	2	Explore Pandas modules - Aggregation and Grouping - Time Series Operations - Pivot and melt function - Use Map, Filter, Reduce and Lambda Functions with Pandas dataframes - TOC - Unpacking NumPy and Pandas | Infosys Springboard (onwingspan.com)	1		3	Contd.			3
	2,5	**2,3 ,4**	3	**Data visualization with python** - Visualization fundamentals - Why visualization	2		2	- Visualizing Amounts - Visualizing distributions			3

				- Coordinate Systems and Axes - Directory of Visualizations Amounts, Distributions, Proportions, x-y Relationships, Uncertainty Basics of python visualization with Matplotlib - Understand the anatomy of a figure - Plot creation - Plotting routines - Basic plot customizations - Saving plots				- Visualizing proportions - Visualizing associations - Visualizing time series **Consider a dataset and infer the relations with the help of different plots.**			
	2,5	2,3, 4	4	- Visualizing trends - Visualizing uncertainty - Visualizing categorical data - visualize proportions - visualize data on multi-plot grid - Composite views for informative summaries of data	1		3	Basics of python visualization with Seaborn The Course Overview - Viewer Page | Infosys Springboard (onwingspan.com)			3
			5	**CIE 1 – Written and Practice Test**				Assessment Review and corrective action			3
	1	4	6	How to create project plan and product backlog for AI project Create Git Repository for following Regression Project - ML / deep learning	2		3	Weekly Assignment			

				Classification Project – ML / deep learning Clustering project – ML / deep learning Natural Language Processing – ML / deep learning							
4	2	**2,3,4**	1	**Peer review** **Mini Project Activity (2)** - **Regression** - **Classification** **(Individual/ Team of 2)** - Define Problem statement (solution to be presented at the semester end) - Create project plan and product backlog - Create git repository for the project - Work progress should be monitored weekly		4		**Data engineering pipeline** **Data Collection** - Population and sample - Types of data ▪ Data type (type 1 (cross sectional, time series), type 2 (univariate, multivariate)) ▪ Variable types (categorical, ordinal, ratio, interval) - Data Collection Key terminologies in Statistics – T **<u>Mini Project Activity</u>** - Data collection for the stated problem	2		1
	2	1,3	2	**Probability** - **Basic concepts** - Conditional and Joint probability - Bayes' Theorem Probability Distributions - Discrete	2		2	**Exploratory data analysis** - overview - EDA goals and benefits **Univariate data analysis** - Characterizing data with descriptive statistics - Univariate distribution plots	1		2

				- Continuous - Central Limit Theorem Infosys Springboard (onwingspan.com) TOC - Probability Distribution using Python | Infosys Springboard (onwingspan.com) **Use relevant python packages to compute Central tendency for the parameters Dispersion for the parameters** **data distribution** **Visualize above computation with various techniques**				- Univariate comparison plots - Univariate composition plots **Mini Project Activity** Data Exploration and analysis for the stated problem			
	2	**2,3 ,4**	3	**Univariate analysis tests** Hypothesis testing Error, Test statistic, type, interpreting test statistics. Understanding p-value	1		3	**Multivariate analysis** Finding relationship in data - Covariance - Correlation	1		2
	2	**2,3 ,4**	4	- Multivariate distribution plot Multivariate comparison plot Multivariate relationship plot Multivariate composition plot			4	**Linear algebra using python** - Scalars - Vectors - Matrices - Tensors Gradients	1		2

				- TOC - Exploratory Data Analysis with Pandas and Python 3.x | Infosys Springboard (onwingspan.com) **Mini Project Activity – Status review** (Data Exploration and analysis for the stated problem)				- **E**igen values and eigen vectors - Norms and Eigen decomposition **Use relevant python packages to perform operations over vectors and matrices.** TOC - Basics of Linear Algebra using Python | Infosys Springboard (onwingspan.com) Interactive Scenario: Introduction to Vector Algebra Using Python (oreilly.com)			
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	2	**2,3 ,4**	6	Statistics and Linear algebra	2		3	Weekly assignment			
5	2,5	**2,3 ,4**	1	Peer review **Mini Project Activity – Status review**		4		**Data Preprocessing** Importance of data preprocessing **Data cleaning** - Assess Data quality - Data anomalies - Detect missing values with pandas dataframe functions: .info() and .isna() - Diagnose type of missing values with visual and statistical methods (eg. chi-squared test of independence) Approaches to deal with missing values ▪ Keep the missing value as is	1		2

								▪ Remove data objects with missing values ▪ Remove the attributes with missing values ▪ Estimate and impute missing values			
	2,5	**2,3 ,4**	2	Practice: Dealing with missing values with different approaches Outliers Detecting outliers ▪ univariate outlier detection ▪ bivariate outlier detection ▪ Time series outlier detection	1		3	Dealing with outliers - Do nothing - Replace with the upper cap or lower cap - Perform a log transformation - Remove data objects with outliers Practice: Dealing with outliers with different approaches TOC - Data Preprocessing | Infosys Springboard (onwingspan.com) TOC - Data Cleaning and Transformation | Infosys Springboard (onwingspan.com)			3
	2,5	**2,3 ,4**	3	Data Integration - Overview - data integration challenges - Approaches - Adding attributes - Adding data objects Practice: data integration	1		3	Data reduction - Distinction between data reduction and data redundancy - Objectives - Methods o numerosity data reduction o dimensionality data reduction	1		2

								Practice: Data reduction with numerosity data reduction method			
	2,5	**2,3 ,4**	4	Data transformation Need for data transformation. - **Normalization** - Standardization Data transformation with - binary coding - ranking transformation - discretization	1		3	Data transformation with - ranking transformation - discretization			3
			5	**CIE 2 – Written and Practice Test**				Assessment Review and corrective action			3
	2,5	**2,3 ,4**	6	**Feature engineering**	2		3	Weekly Assignment			
6	**2,3 ,5**	**2,3 ,4**	1	Peer review **Mini Project Activity – Status review**	4			**Data Splitting** Importance of data splitting - Training set - Validation set - Testing set Underfitting and overfitting Practice : split training and testing data sets in Python using train_test_split() of sci-kit learn. Explore the options of train_test_split()	1		2

	2,3 ,5	**2,3 ,4**	2	**Machine Learning pipeline: Model training** - Supervised Learning: Regression - What is Regression? - Types of regression - Regularization in ML - Real-Life Applications - T - Linear regression Overview Types - simple linear regression - Multiple linear regression - Polynomial linear regression Applications of Linear Regression - T	2		2	Understanding Simple linear regression - Regression equation - Assumptions - Gradient descent - Setting up the regression problem Practice: student score based on study hours Problem statement: • Create a model to analyses the relation between CIE and SEE result • Create a model to analyze the relation between crop yield and rain fall rate Build linear regression model using - Stats model - Scikit learn	1		2
	2,3 ,5	**2,3 ,4**	3	**Model Evaluation & testing** Evaluate regression model: Evaluation Metric - Coefficient of Determination or R-Squared (R2) - Root Mean Squared Error (RSME) - Optimize regression model - Gradient descent	2		2	Cross-validation Why do we need Cross-Validation? Techniques - Hold out method - Leave One Out Cross-Validation - K-Fold Cross-Validation	1		2

	2,3,5	**2,3,4**	4	Multiple Linear Regression - Overview - Assumptions - Normal Equation - Applications Identification and collection of regression dataset - T Perform data exploration, preprocessing and splitting on datasets like - Boston housing price from sci-kit learn datasets - Cricket match result - past data - Performance of a cricket player - past data - Crop yield - past data	2		2	Implementation in python - Build regression model - Evaluate the model - To minimize the cost function			3
			5	**Developmental Assessment**				Assessment Review and corrective action			3
	2,3,5	**2,3,4**	6	**Optimization and performance matrices for regression**	2		3	Weekly Assignment			
7	**2,3,5**	**2,3,4**	1	Peer Review **Mini Project Activity – Status review**		4		Explore other regression algorithms - T Rebuild the model with other regression algorithms such as - Random Forest Regressor - Support Vector Regression - Lasso regression			3

								Evaluate and compare the performance of each.			
	2,3 ,5	**2,3 ,4**	2	Supervised learning – classification What is classification? Types: - Binary classification - Multi-Label Classification - Multi-Class Classification - Imbalanced Classification Classification models Applications - T Practice: Iris dataset from sci-kit learn Perform data exploration, preprocessing and splitting	2		2	Decision trees - What is decision tree? - Understanding Entropy, information gain - How to stop overfitting - Pruning DecisionTreeClassifier - How it works? - Understanding the parameters - Applications	3		
	2,3 ,5	**2,3 ,4**	3	Build decision tree-based model in python for like Breast Cancer Wisconsin (diagnostic) dataset from sci-kit learn Or any classification dataset from UCI , Kaggle			4	Evaluation Metrics for Classification - confusion matrix, - Accuracy - Precision and Recall - Specificity - F1-score - AUC-ROC ▪ How to compute ▪ How does it work	1		2

								▪ When to use			
	2,3,5	**2,3,4**	4	Evaluation Metrics for Classification- contd. Evaluation of decision tree model with different metrics			4	Hyper parameter tuning for DecisionTreeClassifier			3
			5	**CIE 3 – Written and Practice Test**				Assessment Review and corrective action			3
	2,3,5	**2,3,4**	6	Hyper parameter tuning for classification	2		3	Weekly Assignment			
8	**2,3,5**	**2,3,4**	1	Peer review **Mini Project Activity – Status review**		4		Logistic regression - Overview - Types - How does logistic regression work? - Assumptions - Understanding sigmoid function - Applications Practice: build Logistic regression model in python	1		2
	2,3,5	**2,3,4**	2	build Logistic regression model in python Evaluation and optimization of the model	2		2	Support Vector Machine - Introduction to SVM - How does it work? - Applications Practice: Build a SVM Model in python for Fish dataset from Kaggle	2		1
	2,3,5	**2,3,4**	3	Build a SVM Model in python			4	**Ensemble Learning**			3

				How to optimize SVM?				Introduction Basic Ensemble Techniques - Max Voting - Averaging - Weighted Average Advanced Ensemble Techniques - Stacking - Blending - Bagging - Boosting Explore and list the Ensemble Algorithms - T Random Forest - Introduction - How does it work? - Hyper parameters - Applications			
	2,3 ,5	**2,3 ,4**	4	Build Random Forest-based model in python for Breast Cancer Wisconsin (diagnostic) dataset from sci-kit learn Or dataset from UCI , Kaggle			4	Evaluation and optimization			3
			5	**Development Assessment**				Assessment Review and corrective action			3
	2,3 ,5	**2,3 ,4**	6	Comparison of classification algorithms with real world scenario	2		3	Weekly Assignment			

9	3	2,3	1	Peer review **Mini Project Activity – Status review**		4		Unsupervised learning – - What is unsupervised learning? - Common approaches - Challenges - Clustering Types Applications of unsupervised learning - T K-means – Working of K-means How to Choose the Right Number of Clusters?	2		1
	2,3 ,5	**2,3 ,4**	2	**Implementation in python** Evaluation Metrics - Inertia - Dunn Index Evaluate the model using mentioned metrics	1		3	**Contd.**			3
	2,3 ,5	**2,3 ,4**	3	Dimensionality Reduction - Importance of Dimension Reduction in machine learning Common methods to perform Dimension Reduction - T Dimensionality Reduction using PCA in python	2		2	Dimensionality Reduction using PCA in python			3
	5	4,5	4	MLOps - Overview	2		2	- Monitoring - Deployment			3

				- Why MLOps? - ML pipeline - Versioning - Model registry				- Model monitoring			
			5	**CIE 4 – Written and Practice Test**				Assessment Review and corrective action			3
	4	2,3	6	Compare various clustering techniques	2		3	Weekly Assignment			
10	1	3,4	1	Peer review **<u>Mini Project Activity (2)</u>** - Regression - Rebuild with deep learning model - Classification - Rebuild with deep learning model - Analyze the performance of ML and DL **(Individual/ Team of 2)** - Define Problem statement (solution to be presented in the 13th week CIE – 6) - Create project plan and product backlog - Create git repository for the project Work progress should be monitored weekly		4		**Deep learning** - Limitations of Machine Learning - What is deep learning? - Deep learning models - Deep Learning Applications - Deep learning frameworks Group discussion – T Future -Impact deep learning will likely to have on a variety of industries in the next few years. Environment setup - Local - Cloud <u>TOC - Deep Learning with TensorFlow | Infosys Springboard (onwingspan.com)</u>	2		1
	2,3	3,4	2	Introduction to Neural Networks ▪ Understanding	2		2	Introduction to TensorFlow - What is TensorFlow?	1		2

				- Biological Neurons - Artificial neuron /Perceptron - Working of perceptron ▪ Neural network - Architecture - Working of NN - Forward propagation - Back propagation ▪ Activation function - Sigmoid - Tanh - ReLU - LeakyReLU ▪ Cost function - How to measure loss? - How to reduce Loss? - Gradient Descent Get data, and explore Eg. Stroke Prediction Dataset | Kaggle or dataset from any other source Prepare data: Dealing with - missing values - Categorical values				- Why TensorFlow? - TensorFlow ecosystem - TensorFlow architecture - Program Elements in TensorFlow Keras - What is Keras? - Keras APIs – three programming models - Sequential Model - Functional API and - Model Subclassing - Keras layers - Custom Keras Layers TOC - Deep Learning with TensorFlow | Infosys Springboard (onwingspan.com) TOC - TensorFlow for Beginners | Infosys Springboard (onwingspan.com)			

				- Labeled encoding - One hot coding Prepare data : Feature scaling with StandardScalar() or other method Dropping unnecessary features Data splitting Dealing with imbalanced dataset							

	3	2,3, 4	3	- Why do we have to flatten the input data?
				- Understand Keras Dense Layer
				  - Overview
				  - Parameters
				  - Operation
				- Building Shallow Neural Network with Keras Dense Layer
				- Building Deep Neural Network with Keras Dense Layers
				- Create a complete end to end neural network model using Keras Sequential Model and Keras Layer API
				Eg.
				MNIST dataset (classify handwritten numerals) or fashion-MNIST dataset or dataset from other source
					1		3	Keras optimizers
								Keras Metrics
								Keras Losses
								Create a complete end to end neural network – Contd.
								TOC - Learning TensorFlow 2.0 | Infosys Springboard (onwingspan.com)
									1		2

	3	3,4	4	Keras - Callbacks - Commonly used callbacks Monitor neural network performance with TensorBoard - TensorBoard Basics - TensorBoard Setup Understand Model Behavior During Training Reduce overfitting with Dropout Layer	1		3	How to save trained model Local deployment with TensorFlow ModelServer			3
			5	**Development Assessment**				Assessment Review and corrective action			3
	2,3	3,4	6	Building deep learning model with TensorFlow and Keras for use cases	2		3	Weekly Assignment			
11	1,5	2,3, 4	1	Peer Review **Mini Project Activity – Status review**		4		Natural Language Processing Understanding natural language processing NLP approaches – rule based, statistical NLP use cases How to use dictionary? Commonly used NLP tools & libraries Setup environment (spaCy or similar nlp package)	2		1
	2,3	2,3, 4	2	Text processing tasks (Processing Words)	1			Spell Correction	1		2

				Document Assembler Annotation Tokenization - Sentence tokenization - Word tokenization - Visualize frequency distribution of words - Visualize with word cloud Stop word - Dropping stop words - Dropping punctuations			3	Normalization - Stemming - Lemmatization			
	2,3	3	3	Parts of speech tagging Named Entity Recognition	1		3	Vectorizer N-Gram	1		2
	2,3	2.3, 4	4	TF-IDF Build a pipeline for text processing	1		3	Contd.			3
			5	**CIE 5 – Written and Practice Test**				Assessment Review and corrective action			3
	3	2,3	6	NLP – text summarization	2		3	Weekly Assignment			
12	1	2,3, 4	1	Peer review Mini Project Activity – Status review				NLP use case – Sentiment Analysis (SA) What is sentiment analysis? Why is SA important? Business applications for SA How does sentiment analysis work? Transformers	1		2

								Conduct Sentiment analysis to classify movie reviews with - spaCy - TensorFlow and keras			
	1,2, 3,4,	2,3, 4,6	2	NLP use case – Sentiment Analysis (SA) Contd.			4	Ethics in AI - Importance of AI ethics - Ethical challenges of AI - AI code of ethics Group Discussion: Discussion on the Ethics of AI Ethics of AI: Safeguarding Humanity | Professional Education (mit.edu)	1		2
	5	2,3, 4	3	Containers Why containers? What is a docker? How docker works? Components of docker - Docker container - Docker client - Docker daemon - Docker image - Docker registry Install docker on desktop and start the docker tool.	2		2	Publish the container in Registry			3

				TOC - Containers & Images | Infosys Springboard (onwingspan.com) Docker file Docker image Commands to create docker file. Build docker image with docker file create docker container from docker image Run the docker container TOC - Deploying and Running Docker Containers | Infosys Springboard (onwingspan.com) TOC - Docker, Dockerfile, and Docker-Compose (2020 Ready!) | Infosys Springboard (onwingspan.com)							
	5	3,4	4	Deployment strategies	1		3	Contd.			3
			5	**Development Assessment**				Assessment Review and corrective action			3
	1,3	5	6	Using cloud service for MLOps	2		3	Weekly Assignment			

References

Sl. No	Description
1	Hands-On Artificial Intelligence for Beginners By Patrick D. Smith
2	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, By Aurélien Géron
3	Machine Learning with Python for everyone, Mark E Fenner
4	Hands on Data processing in Python , Joy Jafari
5	Deep Learning with TensorFlow2 and Keras , Antonio Gulli, Amita Kapoor,Sujith Pal
6	Cloud Computing, Concepts, Technology and Architecture by Thomas Erl
7	Khan Academy
8	Fundamentals of Data Visualization, Claus O. Wilke
9	Pro Git ,Scott Chacon, Ben Straub
10	Mathematics for Machine Learning, A. Aldo Faisal, Cheng Soon Ong, and Marc Peter Deisenroth
11	Machine Learning, Pipelines, Deployment and MLOps Tutorial | DataCamp
12	MLOps Python Tutorial for Beginners -Get Started with MLOps (projectpro.io)

Cloud Computing and Cyber Security

Under Preparation…….

Internet of Things (IoT)

Course Code- L:T:P

Pre-requisites

Knowledge of basic programming skills in python, networking concepts and basic electronic components

Course Outcomes

Upon completion of the course, the student shall be able to

CO1	**Familiarize with Internet of Things Physical and Logical Design and Levels.**
CO2	**Understand IoT System Management with NETCONF-YANG**
CO3	**Understand Internet of Things, its hardware & software components and applications.**
CO4	**Interpret IoT Application Development**
CO5	**Discuss Security, Privacy and Governance in IoT**
CO6	**Explain IIoT and Case studies for IoT Design**

Course Contents

UNIT - 1: Introduction to Internet of Things

8 Periods

IoT – Definition, characteristics, Physical design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT functional blocks, IoT communication Models, IoT communication API's IoT enabling Technologies – Wireless sensor networks, Cloud Computing, Big Data Analytics, Communication protocols, embedded systems. IoT Levels and Deployment templates – IoT Level-1, IoT Level-2, IoT Level-3, IoT Level-4, IoT Level-5, IoT Level-6, Popular IoT platforms, Domain specific IoTs

UNIT - 2: M2M, IoT System Management with NETCONF-YANG

6 Periods

M2M, Difference between IoT and M2M, SDN and NFV for IoT, Need for IoT Systems Management, Simple Network Management Protocol, Network Operator requirements,

NETCONF, YANG, IoT Systems Management with NETCONG-YANG

UNIT - 3: Elements of IoT

8 Periods

Overview of IoT components-basic building blocks of IoT, Hardware Components- IoT Devices: Raspberry PI, Arduino; Sensors, Actuators, Smart objects and RFID, Software Components-Python Packages of interest for IoT, Networking Protocols

UNIT – 4: IoT Application Development

6 Periods

IoT Design Methodology, Linux on Raspberry PI, Raspberry PI interfaces, Programming Raspberry PI with Python, Data storage on cloud/local server

UNIT - 5: IoT Privacy, Security and Governance

6 Periods

Overview of Governance, Security and Privacy issues, Security, Privacy and Trust in IoT, IoT security life cycle, use of Blockchain in IoT security

UNIT - 6: IIoT and Case Studies on IoT Design

6 Periods

Industrial Internet of Things (IIoT), Differentiate IoT and IIoT, Case Studies- Home Automation, Urban Cities, Environment, Agriculture, Health Care, Transportation.

Reference Books

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759
3. Dr. SRN Reddy, RachitThukral and Manasi Mishra, “Introduction to Internet of Things: A practical Approach”, ETI Labs
4. Raj Kamal, “Internet of Things: Architecture and Design”, McGraw Hill

Suggested E-learning References

1. https://internetofthingsagenda.techtarget.com/
2. https://dzone.com/iot-developer-tutorials-tools-news-reviews
3. https://blog.bosch-si.com/

4. https://www.hackster.io/
5. https://www.libelium.com/
6. https://www.ibm.com/blogs/internet-of-things/
7. https://azure.microsoft.com/en-us/blog/topics/internet-of-things/
8. https://blog.arduino.cc/
9. https://www.raspberrypi.org/blog/
10. www.lemalabs.com/iot

BLOCK CHAIN TECHNOLOGY

OBJECTIVES:

- To understand the concepts of block chain technology
- To understand the consensus and hyper ledger fabric in block chain technology.

OUTCOMES:

- State the basic concepts of block chain
- Paraphrase the list of consensus and Demonstrate and Interpret working of Hyper ledger Fabric
- Implement SDK composer tool and explain the Digital identity for government

UNIT - I

History: Digital Money to Distributed Ledgers -Design Primitives: Protocols, Security, Consensus, Permissions, Privacy- : Block chain Architecture and Design-Basic crypto primitives: Hash, Signature- Hash chain to Block chain-Basic consensus mechanisms.

UNIT - II

Requirements for the consensus protocols-Proof of Work (PoW)-Scalability aspects of Block chain consensus protocols**:** Permissioned Block chains-Design goals-Consensus protocols for Permissioned Block chains.

UNIT - III

Decomposing the consensus process-Hyper ledger fabric components-Chain code Design and Implementation: Hyper ledger Fabric II:-Beyond Chain code: fabric SDK and Front End-Hyper ledger composer tool.

UNIT - IV

Block chain in Financial Software and Systems (FSS): -Settlements, -KYC, -Capital markets-Insurance- Block chain in trade/supply chain: Provenance of goods, visibility, trade/supply chain finance, invoice management/discounting.

UNIT - V

Block chain for Government: Digital identity, land records and other kinds of record keeping between government entities, public distribution system / social welfare systems: Block chain Cryptography: Privacy and Security on Block chain.

TEXT BOOKS:

1. Mark Gates, "*Block chain: Ultimate guide to understanding block chain, bit coin, crypto currencies, smart contracts and the future of money*", Wise Fox Publishing and Mark Gates 2017.
2. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, "*Hands-On Block chain with Hyper ledger: Building decentralized applications with Hyperledger Fabric and Composer*", 2018.
3. Bahga, Vijay Madisetti, "*Block chain Applications: A Hands-On Approach*", Arshdeep Bahga, Vijay Madisetti publishers 2017.

REFERENCE BOOKS:

1. Andreas Antonopoulos, "*Mastering Bitcoin: Unlocking Digital Crypto currencies*", O'Reilly Media, Inc. 2014.
2. Melanie Swa, "*Block chain* ",O'Reilly Media 2014.

WEB REFERENCES:

- NPTEL & MOOC courses titled blockchain technology
- blockgeeks.comguide/what-is-block-chain-technology
- https://nptel.ac.in/courses/106105184/

DRONE TECHNOLOGY & ROBOTICS

COURSE OBJECTIVES

The course should enable the students to:

1. Learn concepts of Drone and Drone Technology
2. Impart knowledge of AI and Drone technology for various domains applications
3. To make the students to understand the basic concepts of UAV drone systems.
4. To introduce the stability and control of an aircraft

COURSE OUTCOMES

1. Design, build and program simple autonomous robots.
2. Implement standard signal processing and control algorithms.
3. Ability to design UAV drone system
4. To understand working of different types of engines and its area of applications
5. To understand static and dynamic stability dynamic instability and control concepts

UNIT-I- Robotics, Sensors and Signal processing Robotics:

Robotics and AI, Embedded Systems, Agent-Task-Environment model, Embodied Systems, Synthetic approaches to science Sensors and signal processing Common sensors and their properties, 1D signal processing, Vision

UNIT-II- AI and the Internet of Things:

AI and the Internet of Things: Real World Use-Cases: Automated vacuum cleaners, like that of the iRobot Roomba, Smart thermostat solutions, like that of Nest Labs

UNIT-III- Introduction to Drones:

Introduction to Drones: Introduction to Unmanned Aircraft Systems, History of UAV drones, classification of drones, System Composition, applications

UNIT-IV- Design of UAV Drone Systems:

Design of UAV Drone Systems: Introduction to Design and Selection of the System, Aerodynamics and Airframe Configurations, Characteristics of Aircraft Types, Design Standards and Regulatory Aspects-India Specific, Design for Stealth.

UNIT-V- Avionics Hardware of Drones:

Avionics Hardware of Drones: Autopilot, AGL-pressure sensors servos-accelerometer –gyros-actuators-power supply-processor, integration, installation, configuration.

TEXT BOOKS

1. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc., 1998.

REFERENCE BOOKS

1. The Art of Robotics: An introduction to engineering, F Martin, Addison-Wesley, forthcoming

DATA ANALYTICS

I. RATIONALE

Data Analytics uses statistical and computational methods to analyze data, aiding informed decision-making. Excel dashboards effectively present vital data at a glance, enhancing user interactivity. A Data Analyst collects, cleans, and visualizes Datasets to solve problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Perform Data Analytics in various business domains for improved decision making

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

CO1 - Elaborate the fundamental concepts of Data Analytics.
CO2 - Apply appropriate statistical techniques to analyze and interpret complex Datasets.
CO3 - Analyze numerical data by creating pivot table.
CO4 - Represent data in terms of various types of charts.
CO5 - Visualize the data using a Python library.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Course Content	Hours
1	**Unit - I Introduction to Data Analytics** 1.1 Data Analytics: An Overview, Importance of Data Analytics 1.2 Types of Data Analytics: Descriptive Analysis, Diagnostic Analysis, Predictive Analysis, Prescriptive Analysis, Visual Analytics 1.3 Life cycle of Data Analytics, Quality and Quantity of data, Measurement 1.4 Data Types, Measure of central tendency, Measures of dispersion 1.5 Sampling Funnel, Central Limit Theorem, Confidence Interval, Sampling Variation	
2	**Unit - II Statistical Analysis** 2.1 Graphical techniques, box plot, skewness and kurtosis, Descriptive Stats 2.2 Correlation and Regression, Data Cleaning 2.3 Imputation Techniques 2.4 Anova and Chi Square 2.5 Scatter Diagram 2.6 Estimation and Hypothesis Testing 2.7 Sampling Distributions, Counting 2.8 Probability,Probability Distributions	
3	**Unit - III Data Analytics with Excel** 3.1 Excel Dashboard: Tables and Data Grids, Dynamic Filters and Controls, Trend Analysis and Forecasting 3.2 Pivot Tables: Creating a Pivot Table Specifying Pivot Table Data 3.3 Changing a Pivot Tables, Calculation Filtering and Sorting a Pivot Table 3.4 Creating a Pivot Chart, Grouping Items 3.5 Updating a Pivot Table, formatting a Pivot Table using Slicers	

4	**Unit - IV Data Visualization** 4.1 Creating a Simple Chart, Charting Non-Adjacent Cells 4.2 Creating a Chart Using the Chart Wizard, Modifying Charts, Moving an Embedded Chart, Sizing an Embedded Chart 4.3 Changing the Chart Type, Changing the Way Data is Displayed, Moving the Legend 4.4 Formatting Charts, Adding Chart Items, Formatting All Text, Formatting and Aligning Numbers, Formatting the Plot Area, Formatting Data Markers 4.5 Pie Charts, Creating a Pie Chart Moving the Pie Chart to its Own Sheet Adding Data Labels, Exploding 1.6 a Slice of a Pie Chart	
5	**Unit - V Data Visualization using Python** 5.1 Overview of Matplotlib and its role in data visualization, Installing and setting up Matplotlib in Python 5.2 Basic plotting with Matplotlib, Line plot, Scatter plots, Bar charts, Histograms, adding titles, labels, and legends to plots 5.3 Changing figure size and aspect ratio, Customizing axes (limits, ticks, and labels) 5.4 Exporting and Saving Visualizations: Saving plots in different formats (PNG, PDF, SVG), Adjusting the resolution and quality of saved plots, creating interactive visualizations using Matplotlib widgets	

SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	**Jinjer Simon**	**Excel Data Analysis: Your visual blueprint for analyzing data, charts, and PivotTables**	**Wiley Publication Edition: 3rd ISBN: 978- 0-470-59160-4**
2	**A. J. Smalley**	**Data Analysis with Excel**	**SAGE Publications Edition: 1st, 2007 ISBN 10: 0070139903 / ISBN 13: 9780070139909**
3	**Fabio Nelli**	**Python Data Analytics: With Pandas, NumPy, and Matplotlib**	**Apress pubication ISBN-13 :978-1484239124 ISBN-13978-1484247372**
4	**Jake VanderPlas**	**Python Data Science Handbook**	**Shroff/O'Reilly Publication ISBN-10-9355422555 ISBN-13-978-9355422552**
5	**Business Analytics with MindTap**	**Jeffrey D. Camm | James J Cochran | Michael J. Fry | Jeffrey W. Ohlmann**	**Cengage Learning India Pvt. Ltd. Publication Edition:4th ISBN: 9789360533533**

V. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://spreadsheetpoint.com/excel/dashboard-in-excel/	Advance Excel
2	https://www.javatpoint.com/how-to-create-a-dashboard-in-exce l	Excel Dashboard
3	https://www.simplilearn.com/tutorials/excel-tutorial/data-an alysis-excel	Data Visualization
4	https://www.freecodecamp.org/news/introduction-to-data-vizua lization-using-matplotlib/	Matplotlib in Python
5	https://archive.nptel.ac.in/courses/106/107/106107220/	Introduction to data analytics

GEO-TECH LAB

Course Code:- L:T:P

I. PRACTICAL / TUTORIAL EXPERIENCES.

Unit	Laboratory Experiment	Hrs.
1	Identification of rocks from the given specimen	2
2	Determination of moisture content of given soil sample by oven drying method	2
3	Determination of specific gravity of soil by pycnometer method	2
4	Determination of Bulk and dry unit weight of soil in field by core cutter method	2
5	Determination of bulk and dry unit weight of soil in field by sand replacement method	2
6	Determination of grain size distribution of given soil sample by mechanical sieve analysis	2
7	Determination of Plastic Limit & Liquid Limit along with Plasticity Index of given soil sample	2
8	Determination of co efficient of permeability by constant head test or Determination of co efficient of permeability by falling head test	2
9	Determination of shear strength of soil by direct shear test	2
10	Determination of shear strength of soil by vane shear test	2
11	Determination of OMC and MDD by standard proctor test of given soil sample	2
12	Determination of OMC and MDD by Modified proctor test of given soil sample	2
13	Determination of CBR value as per IS 2720 (Part-16).	2
14	Use of field tests to idendify type of given soil sample.	2
15	Determination of free Swell index of soil as per IS 2720 (Part 40)	2

LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Vane shear test apparatus- as per 2720 (Part -30)	10
2	Proctor compactometer for light compaction and heavy compaction as per IS specification	11,12
3	CBR apparatus as per IS specification IS 2720 (Part-16).	13
4	425 micron IS Seive and 100ml capacity graduated glass cylinder	15
5	Oven-thermostatically controlled to maintain temperature of 110 degree Celsius to 115 degree Celsius	2,3,4,7,11,12
6	Pycnometer – consisting of 1 kg. honey /fruit jar with plastic cone, locking ring and rubber seal.	3
7	Core cutter apparatus- cylindrical core cutter of steel 100 mm dia x 127.3mm high with 3mm wall thickness beveled at 1mm.	4
8	Sand replacement apparatus- as per IS: 2720(Part-28)	5
9	Mechanical sieve shaker- carries up to 7 sieves of 15 cm to 20 cm dia (as per IS 2720-(Part 4)1985)	6
10	Casagrande liquid limit apparatus- as per IS: 9259-1979	7
11	Constant head permeameter- as per IS:2720(Part-4)1986	8
12	Falling head permeameter -as per IS:2720(Part-4)1986	8
13	Direct shear test apparatus- as per IS: 2720(Part 13) 1986	9

SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Punmia, B.C.	Soil Mechanics and Foundation Engineering	Laxmi Publication (P) ltd., New Delhi, ISBN 9788170087915
2	Murthy, V.N.S.	A text book of soil mechanics and foundation Engineering	CBS Publishers & Distributors Pvt. Ltd., New Delhi 2016 ISBN: 9788123913629
3	Ramamurthy, T.N. & Sitharam,T.G.	Geotechnical Engineering (Soil Mechanics)	S Chand and Company LTD., New Delhi, ISBN: 9788121924573
4	Braja M. Das	Principles of Geotechnical Engineering	Cengage Learning ISBN: 9789355738103
5	Parbin Singh	Engineering And General Geology	S K Kataria and Sons ISBN-13 978-8188458516

LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/N2J-tvEeI4c?si=SgQPoICSbFAuOVLd	Determination of Water Content of Soil by Oven Drying Method
2	https://youtu.be/l6vk0EM4yPg?si=-M6WwrpxOlZYHy94	Determination of Specific Gravity of soil
3	https://youtu.be/5rDHjZ_RJq0?si=V714qwz1vE8f5pSP	Determination of Dry Density of Soil by Core Cutter Method
4	https://youtu.be/YejCi5SEOAU?si=n8w1uAauI7ZgaG9P	Determination of Dry Density of Soil by Sand Replacement Method
5	https://youtu.be/pM-w_cvk1nA?si=3evWNLPjtwFxtsP0	Determination of Liquid Limit and Plastic Limit of Soil
6	https://youtu.be/bmpn5oNDvOs?si=LxcoQUSe_lmL3QQ1	Direct Shear Test
7	https://youtu.be/CAezS3mPzOc?si=9-bIMPqTKy1MuPDG	Grain Size Analysis of Soil

Sr.No	Link / Portal	Description
8	https://youtu.be/c4i_y6u-tsE?si=BjcItf55LqNn2Ihn	Water Content Dry Density Relation Using Light Compaction OMC and MDD
9	https://youtu.be/fCmMW73rP64?si=mdAiq1WPkpc9n1Dl	California Bearing Ratio (CBR) value test
10	https://youtu.be/Lrml0egYtM4?si=ag1mezmk74UAuyCf	Determination of swelling properties (Free Swell Index of Soil)
11	https://smfe-iiith.vlabs.ac.in/List%20of%20experiments.html	Virtual laboratory practical for Soil Mechanics.
12	https://youtu.be/8Q8CZW9-jXE?si=8Yrf2NvS9b5v9kcF	A Soil Investigation Work (Borehole Drilling: SPT & Rock Coring)
13	https://www.ijsrp.org/research-paper-0121/ijsrp-p10935.pdf	The Architectural Study of Sun Temples in India: Based on Location, Construction Material and Spatial Analysis Study
14	https://youtu.be/QuE4tEK-5iY?si=t61uZOWhS_nd5z8H	Shallow Foundation: Plate Load Test
15	https://youtu.be/DjWDOqQjsyQ?si=k43rXl2I19YK9msV	How to conduct SPT / Standard Penetration Test/ Soil Exploration Technique/ Site Investigation

HYDRAULICS & IOT LAB

Course Code- L:T:P

Pre requisites

Basic Knowledge of Hydraulics

Course Outcomes

Upon completion of the course the learner shall be able to

CO1	Assess the flow parameters like discharge, velocity of flow measuring devices
CO2	Determine flow rates, pressure variations, various losses for flow through pipes
CO3	Verify Bernoulli‟s theorem and calculate the coefficient of discharge flow measuring devices
CO4	Calculate the constants in open channel flow
CO5	Identify and analyze the component parts of Pumps
CO6	Recognize and identify the component parts of Turbines

Course Contents

A) HYDRAULICS

List of experiments:

Unit 1: Orifices, Mouthpieces, Notches and weirs

Duration: 15 Periods (L:5 – P:10)

1. Determination of coefficient of discharge of a small orifice by constant head method
2. Determination of C_c of an orifice by finding C_v and C_d.
3. Determination of coefficient of discharge of a mouthpiece by constant head method
4. Determination of coefficient of discharge of a Rectangular and triangular notch.
5. Determination of coefficient of discharge of a trapezoidal notch

Unit 2:Verification of Bernoulli's theorem and study of Pipe flow parameters

Duration: 15 Periods(L:5 – P:10)

1. Verification of Bernoulli's theorem.
2. Determination of coefficient of a discharge of a venture meter.
3. Determination of friction factor in pipe flow.

Unit 3:Open channel flow and Study of Fluid machines

Duration: 15 Periods(L:5 – P:10)

1. Determination of Chezy‟s constant in open channel flow.
2. Study of reciprocating pump
3. Study of centrifugal pump.
4. Study of turbines – Pelton Wheel
5. Study of turbines – Francis Turbine
6. Study of turbines – Kaplan Turbine

KEY Competencies to be achieved by the student

S.No	Experiment Title	Key Competency
1	Coefficient of discharge of small Orifice by constant head.	Regulate the flow Operate stop clock accurately Draw graph between Q vs$H^{1/2}$
3	Hydraulic coefficients of an orifice.	Regulate flow. Note co-ordinate values and measure volume Operate stop clock accurately. State the relation.
4	Coefficient of discharge of mouth piece by constant head.	Regulate the flow. Operate stop clock accurately graph between Q Vs $H^{1/2}$
5	Coefficient of discharge of rectangular notch.	Note readings of head Operate stop clock accurately Draw graph between Q vs$H^{3/2}$
6	Coefficient of discharge of triangular Notch	Note readings of head Operate stop clock accurately. Draw graph between Q vs$H^{5/2}$
7	Coefficient of discharge of trapezoidal notch	Note readings of head Operate stop clock accurately. Compare the results of rectangular and triangular notch.
8	Verify Bernoulli‟s theorem	Note readings of head at various locations Plot hydraulic gradient line and total energy line
9	Coefficient of discharge of Venturimeter.	Note readings of head Operate stop clock accurately. Draw graph between Q vs.$H^{1/2}$
10	Friction factor in pipe flow.	Note readings of head Observe the significance of friction factor of pipe flow.
11	Chezy‟s constant	Note readings of head. Observe the significance in design of section of open channel

Recommended Books

1. Hydraulics Lab Manual by S.K.Likhi, NewAge International PvtLtd
2. Laboratory Manual of Hydraulic and Hydraulic Machines by R.V.Raiker, Prentice Hall India learning Pvt Ltd

Suggested E-learning references

1. http://nptel.ac.in

Suggested Student Activities

1. To carryout market survey for pipes of different sizes and materials available.
2. To visit & submit a report on nearby canal/irrigation structures/dam site to know the usage of notches and weirs.
3. To visit & submit a report on nearby hydel power plant to know the type of turbine installed and its setup.
4. Student is encouraged to attend the Tech fest/ Srujana
5. Paper/Poster presentation
6. Quiz
7. Group discussion
8. Surprise Test

B) IOT - Under Preparation