JSPM University Pune

Faculty of Science and Technology

School of Civil and Environmental Sciences

NEP aligned Syllabus

for

FY M. Tech (Transportation Engineering)

(Effective from AY: 2025-26)

	JSPM University Pune	COURSE STRUCTURE (NEP 2020 Aligned)	
	FACULTY OF SCIENCE & TECHNOLOGY	W. E. F	2024-2025
	SCHOOL OF CIVIL AND ENVIRONMENTAL SCIENCES	RELEASE DATE	01/07/2025
	FIRST YEAR MASTER OF TECHNOLOGY (TRANSPORTATION ENGINEERING)	REVISION NO.	1.0 (NEP)

SEMESTER I (LEVEL 6.5)

COURSE			TEACHING SCHEME				EXAMINATION SCHEME AND MARKS									
			Hours / Week				THEORY (Equal Weightage for CIE and ESE)				PRACTICAL (Equal Weightage for CIE and ESE)		ORAL (Equal Weightage for CIE and ESE)		TOTAL	CREDITS
TYPE	CODE	COURSE NAME	L	T	P	EL	CONTINUOUS INSEMESTER EVALUATION (100 Marks)			END SEMESTER EXAMINATION (100 / 50 Marks)	CONTINUOUS INSEMESTER EVALUATION (50 Marks)	END SEMESTER EXAMINATION (50 Marks)	CONTINUOUS INSEMESTER EVALUATION (50 Marks)	END SEMESTER EXAMINATION (50 Marks)		
							T1 (30 Marks)	T2 (30 Marks)	Assign-ments (40 Marks)							
PSMC	230GMAM03_01	Probability and Statistics	2	1	-	-	30	30	40	100	-	-	-	-	100	3
PCC	231GTEM01_01	Traffic Engineering	3	-	-	-	30	30	40	100	-	-	-	-	100	3
PCC	231GTEM02_01	Pavement Materials and Construction	2	-	-	2	30	30	40	100	-	-	-	-	100	2.5
PCC	250GTEM01_01	Rail and Metro Construction	2	-	-	-	30	30	40	50	-	-	-	-	50	2
MMC	-	Multidisciplinary Minor Course- I	1	-	2	-	-	-	-	-	50	50	50	50	100	2
SEC	230GTEM19_01	Geospatial Analysis	2	-	2	-	-	-	-	-	50	50	50	50	100	3
VSC (HSMC)	230IDCB01_01	Design Thinking and Creativity	1	-	-	2	-	-	-	-	-	-	50	50	50	1.5
AEC (HSMC)	231UENM01_01	Communicative English for Professionals	1	-	2	-	-	-	-	-	50	50	-	-	50	2
RMC	230IRMM01_01	Research Methodology	2	-	-	-	30	30	40	50	-	-	-	-	50	2
LC	230GTEM20_01	Transportation Engineering Lab	-	-	2	-	-	-	-	-	50	50	-	-	50	1
TOTAL			16	1	8	4									**750**	**22**

Sem	Multidisciplinary Minor Course (MMC)	
I (MMC – I)	Course Code	230GRAM24_01
	Course Name	Sensors and Automation
II (MMC – II)	Course Code	230GETM16_02
	Course Name	IoT Basics and Applications

Dr. Prashant Sudani
Programme Coordinator, MTech-TRE

Dr. Aniket Patil
Director (I/C), School of Civil and Environmental Sciences

Dr. R. S. Deshpande
Dean, Faculty of Science and Technology

Dr. Anuradha S. Deshpande
Associate Dean (Academics)

Prof. B.B. Ahuja
Vice Chancellor, JSPM University Pune

JSPM University Pune

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FIRST YEAR MASTER OF TECHNOLOGY (TRANSPORTATION ENGINEERING)		REVISION NO.	1.0 (NEP)

COURSE STRUCTURE (NEP 2020 Aligned)

SEMESTER II (LEVEL 6.5)

COURSE			TEACHING SCHEME				EXAMINATION SCHEME AND MARKS									
			Hours / Week				THEORY (Equal Weightage for CIE and ESE)				PRACTICAL (Equal Weightage for CIE and ESE)		ORAL (Equal Weightage for CIE and ESE)		TOTAL	CREDITS
TYPE	CODE	COURSE NAME	L	T	P	EL	CONTINUOUS INSEMESTER EVALUATION (100 Marks)			END SEMESTER EXAMINATION (100 / 50 Marks)	CONTINUOUS INSEMESTER EVALUATION (50 Marks)	END SEMESTER EXAMINATION (50 Marks)	CONTINUOUS INSEMESTER EVALUATION (50 Marks)	END SEMESTER EXAMINATION (50 Marks)		
							T1 (30 Marks)	T2 (30 Marks)	Assign-ments (40 Marks)							
PCC	230GTEM04_02	Pavement Analysis and Design	2	1	-	-	30	30	40	100	-	-	-	-	100	3
PCC	230GTEM05_02	Highway Structures	2	-	-	2	30	30	40	100	-	-	-	-	100	2.5
PCC	230GTEM06_02	Highway Geotechnology	3	-	-	-	30	30	40	100	-	-	-	-	100	3
MMC	-	Multidisciplinary Minor Course- II	1	-	2	-	-	-	-	-	50	50	50	50	100	2
SEC	230GSEM19_02	Building Information Modelling	2	-	2	-	-	-	-	-	50	50	50	50	100	3
VSC (HSMC)	230IINB02_02	Innovation	1	-	-	2	-	-	-	-	-	-	50	50	50	1.5
AEC (HSMC)	231UENM02_02	Business Communication	1	-	2	-	-	-	-	-	50	50	-	-	50	2
RMC	230IRMM02_02	Research Design and Techniques	2	-	-	-	30	30	40	50	-	-	-	-	50	2
LC	230GTEM21_02	Traffic and Pavement Engineering Lab	-	-	2	-	-	-	-	-	50	50	-	-	50	1
IITP/FP/ CEP	230GTEM22_02	Internship / Field Project / Community Engagement Programme	4 to 6 weeks										50	50	50	2
TOTAL			14	1	8	4									**750**	**22**

Note: A **Postgraduate Diploma** will be awarded if a student exits after first year.
For Exit at the end of first year the student must complete: (Total credits = 8) a) An internship / OJT of 8 - 10 weeks (4 credits)
b) Additional Course 1 (4 credits) (Vocational Skill Course (VSC) / Skill Enhancement Course (SEC))

Sem	Multidisciplinary Minor Course (MMC)	
I (MMC – I)	Course Code	230GRAM24_01
	Course Name	Sensors and Automation
II (MMC – II)	Course Code	230GETM16_02
	Course Name	IoT Basics and Applications

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JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester I

Course Type: PSMC	**Course Title:** Probability and Statistics	
Course Code: 230GMAM03_01	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 3	**Lecture (L):** 2 **Tutorial (T):** 1 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 100 Marks

Prerequisite Courses, if any: -

Course Objectives:

- The course objective of this course is to give students a foundation in statistical and probabilistic analysis, which is usually utilized in a variety of engineering and scientific applications.

Course Outcomes: On completion of the course, learner will be able to

CO1: Understand statistical problem concepts.
CO2: Observe and analyze the behavior of given sample.
CO3: Apply the concept of correlation and regression to find relation between data.
CO4: Learn discrete and continuous probability
CO5: Acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
CO6: Understand of probability principles and be familiar with standard distributions, which can be used to explain phenomena in real life.

Course Contents

Unit I	**Introduction to Statistics**	**(7 Hrs)**
Statistical methods, Scope and limitations, Population and sample, Frequency distribution, Measures of Central Tendency		
Unit II	**Measures of Dispersion**	**(7 Hrs)**
Mean Deviation, Standard Deviation, Coefficient of Variation, Moments, Skewness, Kurtosis		
Unit III	**Correlation and Regression**	**(7 Hrs)**
Coefficient of correlation, Rank correlation, Regression coefficients, Lines of regression		
Unit IV	**Probability Distributions**	**(8 Hrs)**
Binomial Distributions, Mean, Variance and Recurrence formula for Binomial distribution, Poisson Distributions, Mean, Variance and Recurrence formula for Poisson distribution, Normal Distributions		
Unit V	**Statistical Decisions**	**(8 Hrs)**
Significance levels-Tests concerning Mean, Type I & Type II errors, critical region, Null and Alternative hypothesis, Chi-square test for goodness of fit, The T-Test, Confidence interval,		

Forecasting and time series analysis problems		
Unit VI	**Probability**	**(8 Hrs)**
Review, Dependent and Independent events, Addition & Multiplication Rules, Conditional Probability, Total Probability, Bayes' Theorem and independence		

Learning Resources

Text Books:

1. Gupta, S.C. and Kapoor V.K. "Fundamentals of Mathematical statistics", Sultan Chand and Sons, 1978.

Reference Books:

1. Johnson R and G. Bhattacharya, "Statistics-Principles and methods". John Wiley, NY, 1985.
2. Miller & Freund's, "Probability & Statistics, for Engineers & Scientists", 6th Edition, Pearson Education.
3. Vijay K. Rohatgi and A.K. Md. Ehsanes Saleh, "An Introduction to Probability and Statistics", John Wiley, second edition, 2001.
4. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Academic Press, 2009.

MOOC / NPTEL Courses:

1. NPTEL Course "Introduction to theory of probability", Prof. Mrityunjoy Chakraborty, IIT Kharagpur (Link of the Course: http://nptel.ac.in/courses/117105085/)
2. NPTEL Course "Introduction to probability theory and Statistics", Prof. S. Dharmaraja, IIT Delhi (Link of the Course: https://onlinecourses.nptel.ac.in/noc22_ma81/preview)
3. Swayam Course "Probability and Probability Distribution" by Dr. P. Nagesh.(Link of the Course: https://onlinecourses.swayam2.ac.in/cec23_ma09/preview)

Additional Web Resources:

1. https://www.coursera.org/learn/probability-statistics
2. https://www.coursera.org/learn/introductiontoprobability
3. https://www.coursera.org/learn/basic-statistics

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester I

Course Type: PSBC	**Course Title:** Traffic Engineering	
Course Code: 231GTEM01_01	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 3	**Lecture (L): 3** **Tutorial (T): 0** **Practical (P): 0** **Experiential Learning (EL): 0**	**Theory (TH):** 100 Marks

Prerequisite Courses, if any: -

Course Objective:

To develop a comprehensive understanding of the various components of traffic systems, enabling the evaluation of traffic characteristics.

To gain proficiency in traffic measurements and understand their significance in the management of traffic flow and transportation systems.

To acquire an in-depth understanding of the diverse services and facilities available in traffic management, including their design aspects.

To develop a comprehensive understanding of the design aspects of traffic signal systems.

To acquire a knowledge of accident studies, their root causes, and effective preventive measures.

Course Outcomes: On completion of the course, learner will be able to

CO1: Analyse the factors affecting performance of road traffic and the various traffic studies needed for the analysis of traffic flow.

CO2: Measure the traffic through various surveys and techniques.

CO3: Forecast traffic and can propose traffic control techniques.

CO4: Design intersections at-grade and grade separated types for smooth and safe movement of vehicles.

CO5: Evaluate the parking and pedestrian facilities and general safety measures required for highways and expressways.

CO6: Evaluate accident studies, level of service and capacity of roadways using traffic data.

Course Contents

Unit I	**Traffic characteristics**	**(7 Hrs)**

Introduction to traffic engineering, Traffic Characteristics, Road user characteristics– Human factors including reaction time and vehicular characteristics.

Fundamental parameters of traffic flow: volume, spot speed, speed and delay, Traffic flow characteristics, traffic flow variable - speed–flow-density relationship, Moving observer method. Problems on above.

Unit II	**Traffic measurement**	**(8 Hrs)**

Measurement of traffic: Measurement at a point, Measurement over a short section, Measurement over along length of the road.

Traffic studies- Travel time and delay study – Travel time data collection. Origin and destination, analysis, and interpretation of results of classified traffic. Passenger Car Unit (PCU) values.

Unit III	**Capacity of road services**	**(8 Hrs)**

Capacity and Level of Service (LOS), factors influencing roadway capacity, capacity of roads at various levels of service, capacity of intersections. Traffic forecast- factors affecting traffic forecast, Common methods of traffic forecast.		
Unit IV	**Traffic control measures**	**(7 Hrs)**
Principles of traffic control, Traffic regulations and control-Regulation on vehicles, drivers and traffic flow, Traffic control devices– Types & objectives of Road markings, signs, signals and islands, delineators.		
Unit V	**Signals and Intersections**	**(8 Hrs)**
Design of signalized intersections –as per IRC guidelines. Signal system, Problems. Design of other types of intersections at grade such as intersections with markings, channelized intersections, and traffic rotary. Traffic design of grade-separated intersections		
Unit VI	**Design aspect of various traffic facilities and accident study**	**(7 Hrs)**
Design of Traffic facilities – design on-street and off-street parking facilities, pedestrian facilities, bus bays. Design features of expressways and different types of Urban Roads Accident characteristics-causes, studies, investigations and analysis of individual accidents, measures to improve road safety.		

Learning Resources

Text Books:

1. S. C. Saxena “Highway and Traffic Engineering” CBS publication
2. P. R. Rethaliya “Traffic Engineering” Atul Prakashan
3. Yang Xiaokuan and, He Yulong “Introduction to Traffic Engineering” S.K. Kataria & Sons.

Reference Books:

1. KadiyaliL.R.*“Traffic Engineering and Transportation Planning”* Khanna Publication, New Delhi
2. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., *`Highway Engineering’*, NemChand and Bros, Roorkee
3. Nicholas J.Garber, Lester A. Hoel, *“Traffic and Highway Engineering”*, Third Edition Thompson Learning.
4. IRC: SP:41-1994, IRC SP: 31-1992, IRC43-1994, Indian Roads Congress
5. MoRTH *“Type Designs for Intersections on National Highways”* Indian Roads Congress
6. MORTH *“Manual for Road Safety in Road Design”* Indian Roads Congress
7. Relevant Indian Road Congress (IRC) Codes.
8. Indian Highway Capacity Manual (Indo-HCM) CSIR, New Delhi.

MOOC / NPTEL Courses:

NPTEL Course “*Traffic Engineering*”, Prof. Bhargab Maitra, IIT Kharagpur
Link of the Course: https://onlinecourses.nptel.ac.in/noc22_ce41/preview#

JSPM University Pune F.Y. M. Tech "Transportation Engineering" Semester I		
Course Type: PCC	**Course Title:** Pavement Materials and Construction	
Course Code: 231GTEM02_01	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 2.5	**Lecture (L):** 2 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 2	**Theory (TH):** 100 Marks
Prerequisite Courses, if any: -		
Course Objective: • To develop a thorough understanding of the various materials used in pavement construction, such as asphalt, concrete, aggregates, and the properties that make them suitable for different applications		
Course Outcomes: At the end of course, Students will be able to **CO1:** Understand the aggregate gradation for construction of pavement layers. **CO2**: Comprehend the characteristics of the binder material for bituminous roads. **CO3**: Explain the characteristics of bituminous emulsions and cutbacks. **CO4**: Explain the different types of pavement failures and identify suitable maintenance techniques **CO5**: Understand the various applications of highway equipment in road construction, maintenance, and repair. **CO6**: Explain the types of bituminous construction.		
Course Contents		
Unit I	**Aggregates**	**(5 Hours)**
Origin, classification, requirements, properties and tests on road aggregates, concepts of size and gradation - design gradation, maximum aggregate size, aggregate blending by different methods to meet specification.		
Unit II	**Bitumen and Tar**	**(5 Hours)**
Introduction, Origin, Difference between Bitumen and Tar, preparation, advantages of using modified bitumen, properties and chemical constitution of bituminous road binders, Requirements of Bitumen, Desirable Properties of Bitumen,		
Unit III	**Bituminous Emulsions and Cutbacks**	**(5 Hours)**
Preparation, characteristics, uses and tests. Adhesion of Bituminous Binders to Road Aggregates: Adhesion failure, mechanism of stripping, tests and methods of improving adhesion.		

Unit IV	Maintenance of Pavement	(5 Hours)
Introduction, Desirable properties, Marshall Mix design, Failure of pavement – failure in flexible pavement, types of sub-base or base courses failure, types of typical flexible pavement failures, Maintenance of pavement – various maintenance procedure, maintenance of earth road, maintenance of water bound macadam road, maintenance of bituminous surface.		
Unit V	**Highway Equipment**	**(5 Hours)**
Equipments in highway construction: Various types of equipments for excavation, grading and compaction- their working principles, advantages and limitations. Special equipment for bituminous and cement concrete pavement and stabilized soil road construction.		
Unit VI	**Construction of Bituminous Pavement**	**(5 Hours)**
Construction of bituminous pavement- Introduction, types of bituminous construction, Interface treatment, prime coat, tack coat, bituminous surface dressing, seal coat, Penetration macadam, Built-up Spray Grout, Premix methods, Bituminous macadam, Bituminous Premixed carpet, Asphalt concrete, Sheet asphalt, Mastic Asphalt, Bituminous construction procedure – Surface dressing, Grouted or penetration macadam, built-up spray grout, Bitumen bound macadam, Bituminous carpet, Bituminous concrete.		

Learning Resources
Text Books: 1. Khanna and CEG Justo, A. Veeraragavan "*Highway Engineering"*, published by Nem Chand & Bros, Roorkee, 10th edition 2. Prithvi Singh Kandhal, *Bituminous Road Construction in India*,
Reference Books: 1. MoRTH "*Specifications for Roads and Bridge Works*"- Indian Roads Congress, 2013 Fifth revision. 2. MoRTH "*Manual for Construction and Supervision of Bituminous Works*"- Indian Roads Congress, 2001.
MOOC / NPTEL Courses: 1. NPTEL Course "Pavement Materials", Prof. Nikhil Saboo, IIT Madras, Link of the Course: https://archive.nptel.ac.in/courses/105/107/105107219/

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester I

Course Type: PCC	**Course Title: Rail and Metro Construction**	
Course Code: **250GTEM01_01**	**Teaching Scheme:**	**Examination Scheme:**
Credits: 2.0	**Lecture (L): 02** **Tutorial (T): --** **Practical (P): --** **Experiential Learning (EL): 00**	**CIE: 50 Marks** **ESE: 50 Marks**

Prerequisite Courses, if any:

1. Transportation Engineering

Course Objective:

- To understand the components and design of railway and metro infrastructure.
- To explore the construction features of railway and metro system.
- To develop insights into modern rapid transit systems with emphasis on metro acts and guidelines

Course Outcomes: On completion of the course, learner will be able to

CO1: Explain the various components of railway track.
CO2: Understand the function of points and crossings in railways track
CO3: Apply movement controlling methods for rail tracks
C04: Identify methods and requirements of tunnelling
CO5: Evaluate the characteristics and construction methods of major metro projects
CO6: Discuss technical standards, acts and guidelines involved in metro construction.

Course Contents

Unit I	**Introduction to Railways Track**	**(5 Hrs)**
Track structure and components, Gauges, Rails, Coning of wheels, Rail fastenings, Creep, Types of Sleepers, Sleeper density, Ballast		
Unit II	**Points and Crossings**	**(5 Hrs)**
Purpose of providing Points and Crossings, Switches, Heel divergence, Types of crossings, Crossing clearance and angle, Laying and maintenance of points and crossings		
Unit III	**Signalling and Interlocking**	**(5 Hrs)**
Signal classification, Special signal, layout, Control of movements on track, Telecommunication and electrification, Methods of interlocking, Slotting of signals, Detectors, Interlocking of level crossing		
Unit IV	**Tunnelling**	**(5 Hrs)**
Necessity of tunnelling, Tunnelling through rock and soft strata, Methods of tunnelling, Drainage, Ventilation and lightening, Tunnel lining		
Unit V	**Introduction to Rapid transit system**	**(5 Hrs)**

First metro in the world, Characteristics and types of metro, Overview of metro rail constructions in India-Kolkata metro, Delhi metro, Namma metro, Dubai metro, Metro Operations, Fleet Management and passenger information system		
Unit VI	**Metro acts and guidelines**	**(5 Hrs)**
Introduction to Metro acts, Technical Standards of Track Structure for Metro Railways/MRTS, Metro depots, Metro Policy 2017, Standardization and Indigenization of Metro railways		

Learning Resources

Textbooks:

1. Rangwala, *"Railway Engineering*", Charothar Publishing House Pvt. Ltd.
2. S.C.Saxena and S.P.Arora, *"A textbook of Railway Engineering"*, Dhanpat Rai Publications
3. M. Ramachandran, *"Metro Rail Projects in India: A Study in Project Planning"* Oxford University Press
4. M.M.Agarwal, Sudhir Chandra, K.K. Miglani, *"Metro Rail in India for Urban Mobility: Planning, Design, Construction, Maintenance and Recent Developments", Prabha & Co.*

Reference Books:

1. Metro Rail policy, 2017
2. Procedure for Safety Certification and Technical Clearance of Metro Systems, 2015
3. Standardization and indigenization of metro railways and subsystems, 2013
4. Details project reports of various metro projects in India-by DMRC
5. Metro act. Govt. of India, 2002
6. Indian railways permanent way manual published by Indian Railways corrected upto ACS-4, June 2020

MOOC / NPTEL Courses for basic knowledge:

1. NPTEL Course *"Railway Engineering",* Prof. Rajat Rastogi, IIT Roorkee

Link of the Course:
https://nptel.ac.in/courses/105107463

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester I

Course Type: MMC	**Course Title:** Sensors & Automation	
Course Code: 230GRAM24_01	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 2	**Lecture (L):** 1 **Tutorial (T):** 0 **Practical (P):** 2 **Experiential Learning (EL):** 0	**Practical (PR):** 50 marks **Oral (OR):** 50 marks

Prerequisite Courses, if any:

1. Basic Electronics
2. Instrumentation & Control

Course Objectives:

- Study of means of measuring various physical variables using sensors.
- Study of various kinds of actuators.
- Introduce technologies related to upcoming Industry 4.0 paradigm.
- To prepare the learner for a career in industrial automation.

Course Outcomes: On completion of the course, learner will be able to…

CO1: Identify sensor characteristics, calibration and error analysis
CO2: Understand how different physical variables are measured
CO3: Identify different types of actuators and their implementation
CO4: Understand Hydraulic and Pneumatic actuators
CO5: Explain scope and benefit of industry 4.0 technologies.
CO6: Plan, design and implement automation systems

Course Contents

Unit I	Instrumentation & Sensors characteristics	(3Hrs)

Instrumentation & Sensors: Significance of Sensor Measurements, Classification of sensors based on domain, technology and operation.
Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc.
Dynamic Characteristics: Sensor bandwidth and frequency response.
Signal conditioning: Amplifier, Conversion, Filtering, Impedance Buffering

Unit II	Measurements	(3Hrs)

Proximity and Distance Measurement: Limit Switch, Reed switch, Inductive, Capacitive, Hall Effect Sensors, Optical and Ultrasonic distance measurement.
Displacement Measurement: Transducers for displacement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder).
Measurement of Angular Velocity: Tachometers, Digital tachometers and Stroboscopic Methods. MEMS 3 axis Gyroscope.
Acceleration Measurement: Theory of accelerometer and vibrometers, accelerometers, strain gauge based and piezoelectric accelerometers. MEMS 3 Axis Accelerometer.

Unit III	Electrical Actuating systems	(2Hrs)
Electrical Actuating systems: **DC motors:** Review of DC motor, Modelling of DC motor behaviour, Servo Amplifier, DC motor drive. DC Servo Motors. **Stepper Motors:** Characteristics of a Stepper motor, Classification of a Stepper motor, Principle of Operation, Step Angle, Electrical model of energized coil, Drive method, Stepper motor performance.		
Unit IV	**Pneumatic and Hydraulic actuating systems**	**(2Hrs)**
Pneumatic and Hydraulic actuating systems: Components of pneumatic and hydraulic systems, pumps, compressor, filter, control valves, pressure regulation, relief valves, accumulator. Single Acting and Double acting cylinders, Hydraulic motors. Simple single actuator circuits. Harmonic drive, Comb drive.		
Unit V	**Industry 4.0 and Evolution of automation**	**(3Hrs)**
Industry 4.0: Industrial Revolutions 1,2,3,4, Productivity in Manufacturing, how manufacturing changed at each IR, Work Study & motion study, Need and Types of Automation, **Evolution of automation: Automation hierarchy.** Relentless increase in computational power (Moore's law), basket of technologies, which make up Industry 4.0. Reference Architecture Model of Industry 4.0 (RAMI)		
Unit VI	**Automation Circuits**	**(2Hrs)**
Automation Circuits: Introductory Principles in Designing, Electrical and mechanical latch, Logical Design of Automation PLC and SCADA. **Case Studies:** Data Acquisition & Control Systems in Process Plants like chemical, railways and defence applications **Communication: C**ommunication protocols, Device Interfaces		

Learning Resources

Text Books:

1. Clarence W Silva, "*Sensors and Actuators: Control System Instrumentation*", CRC Press USA.
2. Frank Lamb, "*Industrial Automation Hands-On*", McGraw Hill Education 2013.

Reference Books:

1. E.O. Doebelin, "*Measurement Systems (Applications and Design)*", McGraw Hill., 5th Ed.
2. A. Smaili and F. Mrad, "*Applied Mechatronics*", OXFORD university press.
3. Thomas Beckwith, N.Lewis Buck, "*Mechanical Engineering Measurement*", Roy Marangoninarosa Publishing House, Bombay
4. Kataria Sanjay *"Industrial Automation Solutions For Plc, Scada, Drive And Field Instruments: Easy To Learn Industrial Automation"*
5. Arshadeep Bagha , Vijay Madisetti "I*nternet of Things A Hands-on Approach*", Universities Press 2018

MOOC / NPTEL Courses:

1. https://nptel.ac.in/courses/108/105/108105064/
2. https://nptel.ac.in/courses/112/107/112107242/
3. https://nptel.ac.in/courses/108105088
4. https://nptel.ac.in/courses/106105195

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester I

Course Type: MMC	**Course Title:** Sensors & Automation	
Course Code: 230GRAM24_01	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 2	**Lecture (L):** 1 **Tutorial (T):** 0 **Practical (P):** 2 **Experiential Learning (EL):** 0	**Practical (PR):** 50 marks **Oral (OR):** 50 marks

Prerequisite Courses, if any: -

List of Laboratory Experiments (Minimum 10)

	Group A
1.	Characterization of Temperature Sensor (RTD).
2.	Linear Conveyor Control System
3.	Study of Two-Dimensional Position Control
4.	Demonstration of Electro hydraulic Controls through Trainer Kit
5.	Characterization of Linear Variable Differential Transformer (LVDT) (Virtual Lab) https://sl-coep.vlabs.ac.in/exp/characterize-temperature-sensor/
	Group B
6.	Demonstration of Electro pneumatic Controls through Trainer kit
7.	Study of Rotary Encoder for Speed & angle measurement
8.	Data acquisition system
9.	Demonstration of Programmable Logic Controller (PLC) based Servo motor Controller
	Group C
10.	Characterization of Strain Gauges (virtual Lab) https://sl-coep.vlabs.ac.in/exp/strain-gauge-sensor/

Virtual LAB Links:

1. Lab Name: COEP, Pune

https://sl-coep.vlabs.ac.in/exp/characterize-temperature-sensor
https://sl-coep.vlabs.ac.in/exp/strain-gauge-sensor

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester I

Course Type: SEC	**Course Title:** Geospatial Analysis	
Course Code: 230GTEM19_02	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 3	**Lecture (L):** 2 **Tutorial (T):** 0 **Practical (P):** 2 **Experiential Learning (EL):** 0	**Practical (PR):** 50 marks **Oral (OR):** 50 marks

Prerequisite Courses, if any:

1. Basic Computer Knowledge
2. Remote Sensing basics

Course Objectives:

- Apply the concepts of Photogrammetry and its applications such as determination of heights of objects on terrain.
- Understand the basic concept of Remote Sensing and know about different types of satellite and sensors.
- Illustrate Energy interactions with atmosphere and with earth surface features, interpretation of satellite and top sheet maps.
- Understand different components of GIS and Learning about map projection and coordinate system.
- Develop knowledge on conversion of data from analogue to digital and working with GIS software.

Course Outcomes: On completion of the course, learner will be able to

CO1: Understand the concepts of Photogrammetry and compute the heights of objects **CO2:** Apply knowledge of GIS and understand the integration of Remote Sensing and GIS **CO3:** Understand the basic concept of GIS and its applications, know different types of data representation in GIS

CO4: Understand and Develop models for GIS spatial Analysis and will be able to know what the questions that GIS can answer are

CO5: Apply knowledge of GIS software and able to work with GIS software in various application fields

CO6: Illustrate spatial and non-spatial data features in GIS and understand the map projections and coordinates systems

Course Contents

Unit I	**Introduction to GIS**	**(5 Hours)**

Basic concepts: Definition and history, Components of GIS, Recent trends and applications of GIS; Data structure and formats, Spatial data models – Raster and vector, Data base design- editing and topology creation in GIS, Linkage between spatial and non-spatial data, Data inputting in GIS. Rectification, Transformation Methods; Root Mean Square (RMS) Error.		
Unit II	**Data Types and Data Models**	**(5 Hours)**
Data Types; Spatial Data; Non-Spatial Data, Data Input; Existing GIS Data, Metadata; Conversion of Existing Data, Creating New Data, Data Models; Vector Data Model; Raster Data Model; Integration and Comparison of Vector and Raster Data Models.		
Unit III	**Spatial Data Editing**	**(5 Hours)**
Types of Digitizing Errors, Causes for Digitizing Errors; Topological Editing and Non-topological Editing; Other Editing Operations; Editing Using Topological Rules.		
Unit IV	**Attribute Data and Data Exploration**	**(5 Hours)**
Attribute Data in GIS, Attribute Data Entry, Manipulation of Fields and Attribute Data, Data Exploration; Attribute Data Query, Raster Data Query, Map- Based Data Manipulation,		
Unit V	**Spatial Analysis**	**(5 Hours)**
Spatial Data: Definition, Analysis, Processes & Steps, Software and Tools, Geodatabase Model, Role of Databases in GIS, Creating, Editing and Managing, Classification scheme of Vector- Based and Raster- Based GIS Operation Raster- Based Techniques: Methods of reclassification, overlay analysis, Digital Terrain Analysis and Modeling- TIN and DEM, Surface representation and analysis, Slope and Aspect, Geographic Visualization Data Classification, Map Comparison,		
Unit VI	**Geo Statistical Analysis Techniques:**	**(5 Hours)**
Introduction to Spatial Interpolation: Control Points, Global Method- Trend surface analysis, regression model, local methods- Thiessen polygons, density estimation, Inverse Distance weighted Interpolation, Kriging- Ordinary Kriging and Universal Kriging, GIS and decision support system, Introduction to AHP, basic principle of AHP. Principal and components of multiple criteria decision making		

Learning Resources

Text Books:

1. Jahne, B. *"Digital Image Processing"* New York: Springer-Verlag
2. Lillsand, R.M. and R.W. Kiefer, *"Remote Sensing and Image Interpretation"*, New York: Wiley.

Reference Books:

1. Pratt, W.K., "*Digital Image Processing"* New York Wiley.
2. Jain, A.K., "*Fundamentals of Digital Image Processing*", Englewood Cliffs, NJ, Prentice Hall.

MOOC / NPTEL Courses:

1. Link of the Course: https://archive.nptel.ac.in/courses/107/105/107105088/, IIT Kharagpur

Additional Web Resources:

1. https://docs.qgis.org/3.28/en/docs/training_manual/index.html

JSPM University Pune F.Y. M. Tech "Transportation Engineering" Semester I		
Course Type: SEC	**Course Title:** Geospatial Analysis	
Course Code: 230GTEM19_02	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 3	**Lecture (L):** 2 **Tutorial (T):** 0 **Practical (P):** 2 **Experiential Learning (EL):** 0	**Practical (PR):** 50 marks **Oral (PR):** 50 marks
Prerequisite Courses, if any: -		

List of Laboratory Experiments

1. Familiarization with GIS Software, Data Input
2. Geo Referencing and Projections
3. Digitization of Map/ Toposheet
4. Creation of Thematic Maps
5. Base Map Preparation
6. Data Conversion – Vector to Raster, Raster to Vector
7. Adding Attribute Data – Querying on Attribute Data
8. Vector Analysis
9. Raster Analysis
10. Map Composition
11. Developing Digital Elevation Model
12. Simple Applications of GIS in Transportation Engineering

GIS SOFTWARE: Arc GIS 10.3

TEXT BOOKS:

1. "*Concept and Techniques of GIS*" by C.P.L.O. Albert, K.W. Yong, Printice Hall Publishers

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester I

Course Type: VSC	**Course Title:** Design Thinking and Creativity	
Course Code: 230IDCB01_01	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 1.5	**Lecture (L):** 1 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 2	**Oral (OR):** 50 marks

Prerequisite Courses, if any: -

Course Objectives:

Course Outcomes: On completion of the course, learner will be able to
CO1: Describe the Design thinking principles of Human Centeredapproach to real life problem solving
CO2: Demonstrate through the project-oriented approach thebasic theories and knowledge of design thinking and master the tools and principles of design thinking, and their application.
CO3: Experiment with design thinking principles to come up with innovative solutions to the problems, as new products, services, experiences, or new Business models.
CO4: Analysis of various applications of design thinking.
CO5: Determine the suitable design thinking approach to solve theproblem.
CO6: Develop a low fidelity prototype of the alternative Solutions to theidentified Problem

Course Contents

Unit I	**Design Thinking Introduction**	**(3 Hrs)**

Introduction & definition of design thinking, Principles, the process, Innovation in design thinking, importance of design thinking method, the relationship between design thinking and innovation & entrepreneurship. Five step method of Design thinking (Empathize,Define, Ideate, Prototype, Test).
Class Activity: Students are asked to form groups. Classroom Project begins: Share ideas with team members, discuss about meaning of DT, it"s importance in today"s world.
Case: ABC Nightline- IDEO Shopping Cart, (the video can be shown in classroom for discussion.)

Unit II	**Awareness of the five stages of design thinking, Empathize & Define**	**(5 Hrs)**

Stage 1 & 2: Empathize & Define
Introduction of the tools in the stage of empathy. Emphasize the skills and tactics of interviews. Understand the persona, Methods of collecting the data from interviews. The empathy map. Establishing the Problem statement using 5 Why"s technique as a tool to understand the root cause.
(Ex.26/11 attack, rescue team not able to move with ambulance due to stagnation) & Emphasis on establishing the "Problem Statement" only for faculty ref.
Classroom Project: Each group will write the Problem Statement by using Stages of Empathy and

technique of 5 Why"s. Each group member will do the interview round for writing the problem statement. Take record of the interview process.

Unit III	Ideate	(5 Hrs)
Stage 3, Ideate Process to Find and select ideas, The creative process and creative principles, Creativity techniques, Evaluation of ideas. Idea Generation Stage-Fine tuning process of ideas (every team member comes up with 1 idea and passes on to next person, each idea will be fine-tuned by each team member and ultimately matured ideas are established- round robin method) and selection of best three ideas by voting method. Classroom Project: Through the project, students will know how to propose the point of view (POV) statement based on the analyses of data from user research via the brainstorm and others. Students are asked to submit ideas as many as possible. Note in POV practice: please define the problem which each group is finally going to resolve. The practice process: unpack the interview data, select one interviewee as analysis target and solution. Make inferences to generate ideas and POV statement. Please remember: No solution in the POV statement.		
Unit IV	**Prototype & Test**	**(4 Hrs)**
Stage 4 and 5, Prototype & Test Prototype and test stage, Prototype model, The role of prototype and test in the innovation and entrepreneurship. prototype and the way to test, visualization of ideas. Classroom project: groups design the prototype to show ideas about the innovative way to resolve the problem in the dormitory life. Concerning the test practice: Ask other group to visit your group and test your prototype, and then in turn.		
Unit V	**Understanding Business Viability**	**(3 Hrs)**
Checking the Business viability of selected ideas derived in stage 3 using BXT model, Tools for the Design Journey, Pillars of Design thinking.		
Unit VI	**Presentation and closure**	**(3 Hrs)**
The student groups will give the final presentation of the project they have done (Unit 1 to 5) and close the DT process.		

Learning Resources
MOOC / NPTEL Courses: **Additional Web Resources:** 1. How design thinking is transforming lives in rural India -https://www.youtube.com/watch?v=EH9u1bHqwpc. 2. Design Thinking in Netflix | | Case Studio - 04 - https://www.youtube.com/watch?v=8P8gspd_Bx8)

JSPM UNIVERSITY PUNE
Recognized by UGC u/s 2 (f) of UGC Act 1956 and enacted by the
State Government of Maharashtra - JSPM University Act, 2022 (Mah.IV of 2023)

JSPM University Pune **F.Y. M. Tech "Transportation Engineering"** **Semester I**		
Course Type: AEC	**Course Title:** Communicative English for Professionals	
Course Code: 231UENM01_01	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**

Credits: 2	**Lecture (L):** 1 **Tutorial (T):** 0 **Practical (P):** 2 **Experiential Learning (EL):** 0	**(Practical):** 50 Marks

Prerequisite Courses, if any: Nil

Course Objectives:

- Remember the different aspects of communication.
- Understand basics of grammar, sentence construction and vocabulary to write and speak effectively.
- Apply appropriate modes of expressions in written and oral communication.
- Analyze the attitude and aptitude of the speaker in the professional sphere for effective listening skill.
- Evaluate the non-verbal clues of the speaker for effective communication.
- Cultivate students to create commendable personalities.

Course Outcomes: On completion of the course, learner will be able to
CO1: Understand and practice different types of communication.
CO2: Reflect on basic language skills-listening, speaking, reading, and writing and attempt tasks by using functional grammar and vocabulary effectively.
CO3: Reproduce their understanding of concepts/principles of business communication skills.
CO4: Build relationships, solve problems, ensure understanding, resolve conflicts, and improve accuracy.
CO5: Become more self-confident and develop a strong determination.
CO6: Build social skills with ease and comfort.

Course Contents

Unit I	**Foundation of Communication**	**(3 Hrs)**
Importance and types of Communication, Types of communication: Verbal and Non-verbal, Channels of communication, Barriers to Effective Communication and ways to mitigate.		
Unit II	**Language Competency/Functional English**	**(3 Hrs)**
Basic rules of Phonics, Parts of Speech, Sentence Constructions, Prefixes and Suffixes		
Unit III	**Business Communication at Workplace**	**(2 Hrs)**
Types of business letter, Characteristics of good business letter, Letter Components and Layouts, Email Communication, memo		
Unit IV	**Mindful Listening**	**(2 Hrs)**
The purpose and types of listening, Principles of effective listening, Ways to improve listening skills, Role of Active listening in professional interactions and conflict resolutions		
Unit V	**Art of Effective Verbal Interaction**	**(2 Hrs)**

Identifying common fears and anxieties related to speaking, Techniques to build confidence and overcome stage fright, Voice modulation, pitch, and pace for engaging delivery, Impromptu Speaking		
Unit VI	**Effective Body Language**	**(3 Hrs)**
Basic Principles of Body Language and Nonverbal Communication, Signs and Clusters, Kinesics & Proxemics, Gesture & Posture		

Learning Resources
Textbook: Adair, John. Effective Communication. London: Pan Macmillan Ltd., 2003.
Reference Book: 1. Carnegie, Dale. The Quick and Easy Way to Effective Speaking. New York: Pocket Books, 1977. Mitra, Barun. Personality Development & Soft Skills, New Delhi: Oxford Press, 2011
MOOC / NPTEL Course: NPTEL Course “Developing Soft Skills and Personality” by Prof. T Ravichandran, IIT Kharagpur **Link of the Course:** https://nptel.ac.in/courses/109104107 **Additional Web Resources:** https://www.britishcouncil.in/english/online/resources-websites/moocshttps://www.dailywritingtips.com/

JSPM University Pune F.Y. M. Tech "Transportation Engineering" Semester I		
Course Type: AEC	**Course Title:** Communicative English for Professionals	
Course Code: 231UENM01_01	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 2	**Lecture (L):** 1 **Tutorial (T):** 0 **Practical (P):** 2 **Experiential Learning (EL):** 0	**(Practical):** 50 Marks
Prerequisite Courses, if any: - Nil		

List of Laboratory Experiments	
Group A	
1.	Phonics
2.	Parts of Speech
3.	Presentation Skills
4.	Tenses
5.	Verbal and Non-verbal Communication
Group B	
6.	Listening Skills
7.	Reading Skill
8.	Body Language
9.	Formal Writing
10.	Email Writing
Virtual LAB Links:	

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester I

Course Type: RMC	**Course Title:** Research Methodology	
Course Code: 230IRMM01_01	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 2	**Lecture (L):** 2 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 50 marks

Prerequisite Courses, if any: -

Course Objectives:

- To develop a research orientation among the students and to acquaint them with fundamentals of research methodology, research process and research design
- To develop skills in effectively searching for relevant literature sources and familiarize with formulation of research hypotheses
- To establish an understanding of various data types, data collection methods, and the importance of research ethics and integrity.
- To acquaint students with the process of crafting research reports and thesis

Course Outcomes: On completion of the course, learner will be able to

CO1: Demonstrate Proficiency in Research Fundamentals
CO2: Identify and Frame Research Problems
CO3: Conduct Comprehensive Literature Reviews and Formulate Testable Hypotheses
CO4: Collect and Differentiate the Types of Research Data
CO5: Practice Ethical Research Conduct
CO6: Create Effective Scientific Papers Through the Application of Scientific Writing Principles

Course Contents

Unit I	**Introduction to Research**	**(5 Hrs)**

Meaning and Definition of Research, Objectives of Research, Characteristics of Research Need of Research, Importance of Research, Types of Research

Unit II	**Problem Identification & Formulation**	**(5 Hrs)**

Research Process, Research design, Defining the Research Problem, Formulation of Research Problem, Errors in selecting Research Problem, Research Questions, Research Methods vs. Research Methodology

Unit III	**Literature Review and Hypothesis**	**(5 Hrs)**

Literature Review Concepts and Theories, Meaning of Hypothesis and Formulation of Hypothesis, Sources of Hypothesis, Characteristics of Hypothesis, Role of Hypothesis, Tests of Hypothesis

Unit IV	Research Data	(5 Hrs)
Sampling Design and Types and Techniques, Types of Data, Methods of Data Collection, Questionnaires, Observation Method and Interview Method, Case Study Method		
Unit V	**Ethics in Research**	**(5 Hrs)**
Ethics in conduct of Research, Ethical challenges in Data Collection, Ethical issues in scientific Publication, Plagiarism and Self-Plagiarism, Cases of Scientific Misconduct		
Unit VI	**Scientific Writing**	**(5 Hrs)**
Preparation of Title, Keywords and Methods Section, Preparation of Figures and Schematics, Citations and Referencing, Report writing and Presentation, Layout of a Research Paper, Research Journals and its Impact factor, Research Metrics.		

Learning Resources

Text Books:

1. Wayne Goddard, Stuart Melville, "*Research Methodology: An Introduction*", Juta, Lansdowne, Second Edition.
2. Ranjit Kumar "*Research Methodology*: A Step-by-Step Guide for Beginners", SAGE Publications Pvt. Ltd Fourth Edition.
3. Dr. C. R. Kothari, "*Research Methodology: Methods and Trends*", New Age International Publishers, Third Edition

Reference Books:

1. Nicholas Walliman, *"Research Methods: The Basics",* Routledge – Taylor and Francis Group, Third Edition.
2. Vinod Chandra, Anand, Hareendran "*Research Methodology*", Pearson 1st Edition
3. Dr. Prabhat Pandey, Dr. Meenu Mishra Pandey, "Research Methodology: Tools and Techniques", Bridge Center, 2015.
4. Alan Bryman & Emma Bell, "*Business Research Methods*", Oxford University Press, Third Edition.

MOOC / NPTEL Courses:

1. NPTEL Course "*Research Methodology*", Prof. Edamana Prasad, Prof. Prathap Haridoss, IIT Madras.
   Link of the Course: https://onlinecourses.nptel.ac.in/noc23_ge36/preview
2. NPTEL Course "*Research Methodology*", Prof. Soumitra Banerjee, IISER Kolkata.
   Link of the Course: https://archive.nptel.ac.in/courses/127/106/127106227/

Additional Web Resources:

1. https://www.coursera.org/learn/research-methods
2. https://www.coursera.org/specializations/data-collection
3. https://www.coursera.org/learn/introduction-to-academic-writing

JSPM University Pune F.Y. M. Tech "Transportation Engineering" Semester I		
Course Type: LC	**Lab Course Title:** Transportation Engineering lab	
Course Code: 230GTEM20_01	**Teaching Scheme:**	**Examination Scheme:**
Credits: 1	**Lecture (L):** **Tutorial (T):** **Practical (P): 2** **Experiential Learning (EL):**	**Practical: 50**
Prerequisite Courses, if any: -		

List of Laboratory Experiments	
Group A Test on soil	
1.	Determination of grain size analysis
2.	Determination of dry density of soil in-place by using core-cutter method
3.	Determination of dry density of soil in-place by using sand replacement method
4.	Determination of California Bearing Ratio (CBR) for soil
Group B Test on aggregates	
5.	Aggregate gradation
6.	Shape tests
7.	Los Angeles abrasion value
8.	Aggregate impact value
9.	Aggregate crushing test
10.	Soundness test
Group C Test on traffic studies	
11.	Traffic roadway capacity

Virtual LAB Links:

1. Lab Name: Transportation Engineering
   Link of the Virtual Lab: https://ts-nitk.vlabs.ac.in/

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester II

Course Type: PCC	**Course Title:** Pavement Analysis and Design	
Course Code: 230GTEM04_02	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 3	**Lecture (L):** 2 **Tutorial (T):** 1 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 100 marks

Prerequisite Courses, if any:
1. Transportation Engineering

Course Objectives:
The course aims at
- To understand the design factors considered for the design of flexible and rigid pavements.
- To estimate the stresses and strains in flexible pavements from layer theories.
- To determine the stresses and strain for rigid pavements.

Course Outcomes: On completion of the course, learner will be able to
CO1: Students will be able to understand the basics of different pavements, functions and requirements of pavements.
CO2: Students will gain the knowledge of soil characteristics, sub base strength analysis which is the important aspect of pavement.
CO3: Students will be able to apply their knowledge in the estimation of distresses and strains of flexible and rigid pavements.
CO4: Students will be able to apply their knowledge in the design of flexible pavements using specific guidelines.
CO5: Students will be able to apply their knowledge in the design of rigid pavements using specific guidelines.
CO6: Students will master in developing the strategies for performance and measurements, Rehabilitation and maintenance, Life-cycle cost analysis.

Course Contents

Unit I	**Introduction to Pavement Engineering**	**(5 Hours)**
Overview of pavement engineering, Types of pavements (flexible and rigid), Functions and requirements of pavements, Importance of pavement design and analysis, Historical perspective and evolution of pavement design		
Unit II	**Geotechnical Aspects of Pavement Design**	**(5 Hours)**

Soil classification and properties, Subgrade characterization, Soil compaction and stabilization techniques, Importance of geotechnical investigations in pavement design, Geosynthetics and their role in pavement engineering		
Unit III	**Traffic and Load Analysis**	**(5 Hours)**
Traffic load analysis and classification, Axle load spectra and traffic loading models, Impact of traffic on pavement design, Load equivalency factors, Traffic data collection methods and analysis		
Unit IV	**Flexible Pavement Design**	**(5 Hours)**
Mechanistic-Empirical (ME) design approach, Layered elastic analysis, Material characterization and properties, Design procedures for flexible pavements, Sensitivity analysis and optimization in flexible pavement design		
Unit V	**Rigid Pavement Design**	**(5 Hours)**
Thickness design for rigid pavements, Joint design and detailing, Dowel bars and tie bars, Load transfer mechanisms, Design considerations for concrete pavements		
Unit VI	**Pavement Performance Evaluation and Maintenance**	**(5 Hours)**
Pavement distress types and causes, Pavement condition surveys, Performance indicators and measurements, Rehabilitation and maintenance strategies, Life-cycle cost analysis.		

Learning Resources

Text Books:

1. Papagiannakis A. T. and Masad E. A., "*Pavement Design and Materials*", Willey Publishers, First Edition.
2. Yang Huang, "*Pavement Analysis and Design*", Pearson Education, 2nd edition

Reference Books:

1. Croney D. and Croney P., "*The Design and Performance of Road Pavements*", McGraw Hill Book, Third Edition
2. IRC: 37-2018 "*Guidelines for the Design of Flexible Pavements"* The Indian Roads Congress, New Delhi, India.
3. IRC: 58-2015 "*Guidelines for the Design of Plain Jointed Rigid Pavements for Highways"* The Indian Roads Congress, New Delhi, India.
4. Ministry of Road Transport and Highways. "*Specifications for Road and Bridge Works"*, Indian Roads Congress, India, Fifth Edition.

MOOC / NPTEL Courses:

1. NPTEL "Introduction to pavement design", Prof. Tom V. Mathew, IIT Bombay. Link of the Course: https://www.civil.iitb.ac.in/~vmtom/nptel/401_InTse/web/web.html

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester II

Course Type: PCC	**Course Title:** Highway Structures	
Course Code: 230GTEM05_02	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 2.5	**Lecture (L): 2** **Tutorial (T): 0** **Practical (P): 0** **Experiential Learning (EL): 2**	**Theory (TH):** 100 marks

Prerequisite Courses, if any: -

Course Objective:

To acquire an understanding of fundamental principles and procedures involved in the investigation of bridges and culverts.

To gain knowledge of different types of bridges, loading standards, and the design and construction aspects of bridge components.

To provide students with understanding of foundation choices for bridge, and the practical application of other foundations.

To acquire knowledge of inspection and maintenance of bridges, focusing on both substructure and superstructure elements.

To develop understanding of highway constructions, and quality control aspects.

To introduce students to various special structures and devices used in transportation system.

Course Outcomes: On completion of the course, learner will be able to

CO1: Demonstrate the knowledge of highway structures and their various components.

CO2: Investigate the highway structures.

CO3: Make informed decisions regarding the choice of foundations.

CO4: Conducting inspections of bridges, implementing maintenance strategies for substructures and superstructures

CO5: Demonstrate knowledge of various highway constructions and able to implement quality control measures.

CO6: Make competent choice of special structures and instrumentations

Course Contents

Unit I	**Investigation of Bridges and Culvert**	**(5 Hrs)**
Introduction, Investigation for Bridges and Culverts, Investigations for Important Bridges, Design Flood Discharge for bridges, Linear Waterway of Bridges.		
Unit II	**Bridge Types and Standards**	**(5 Hrs)**
Types of Bridges and Loading Standards, Piers and Abutments, Superstructure- Design Aspects, Superstructure- Construction		
Unit III	**Foundation Structures**	**(5 Hrs)**
Choice of Foundation for Piers and Abutments, Setting out for Piers and Abutments, Open Foundation, Pile Foundations, Well Foundation- Case Studies.		
Unit IV	**Inspection and Maintenance**	**(5 Hrs)**
Inspection of Bridges, Maintenance of Bridges- substructure, Maintenance of superstructure – Girders, Tests on Compaction, Rebuilding of Bridges		
Unit V	**Highway constructions and quality control**	**(5 Hrs)**

Grade Separators, River Training and Protection Works, Embankments, Approaches, Layers in Flexible and Rigid pavements, Quality Control Aspects.		
Unit VI	**Special Structures and Devices**	**(5 Hrs)**
Retaining walls, small box culverts, large pipe headwalls, ITS devices, reinforced soil slopes, sound abutment walls, overhead signs and traffic signals.		

Learning Resources

Textbooks:

1. D. R. Pathak and H. K. Gite, *"Highway Engineering"* Nirali Prakashan, 2nd Edition
2. Rangwala, *"Highway Engineering"* Charotar publishing house, 12th Edition
3. Rangwala, *"Bridge Engineering"* Charotar publishing house, 17th Edition
4. L. R. Kadiyali, *"Highway Engineering"* Khanna Publisher, 10th Edition.

Reference Books:

1. S. Ponnuswamy, *"Bridge Engineering"*, McGraw Hill Education, 3rd Edition
2. Das, P.C., *"Management of highway structures"*, Thomas Telford Publishing, London, 1st Edition
3. Narendra Taly, *"Highway Bridge Superstructure Engineering"*, CRC Press, 1st Edition.
4. Great Britain: Highways Agency, *"Highway Structures: Inspection and Maintenance: Inspection: Bd 63 Loose Leaf"*, Stationery Office Books (TSO).

MOOC / NPTEL Courses for basic knowledge:

NPTEL Course "*Bridge Engineering*", Prof. Piyali Sengupta, IIT Dhanbad

Link of the Course:

https://onlinecourses.nptel.ac.in/noc23_ce81/preview

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester II

Course Type: PCC	**Course Title:** Highway Geotechnology	
Course Code: 230GTEM06_02	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 3.0	**Lecture (L): 03** **Tutorial (T): --** **Practical (P): --** **Experiential Learning (EL): 00**	**Theory (TH):** 100 marks

Prerequisite Courses, if any:

1. Soil Mechanics

Course Objective:

- To study soil classification for highway engineering purpose.
- To know the significance of the water drainage from subsoil of highway
- To understand the concept of the mechanics of stresses in soils and effects of pore pressure.
- To acquire an in-depth understanding of the stability analysis of embankment slopes and earth pressures.
- To know the various ground improvement techniques in the highway construction.
- To acquire a knowledge of rock mechanics.

Course Outcomes: On completion of the course, learner will be able to

CO1: Investigate soil classification methods specific to highway engineering applications.
CO2: Explore the importance of water drainage from the subsoil of highways and its implications.
CO3: Apply the concept of shear strength and pore water pressure.
CO4: Apply the concept of slope stability and earth pressure.
CO5: Identify and imply appropriate ground improvement techniques in highway construction.
CO6: Carry out geomechanics classification and able to apply concept of rock mechanics

Course Contents

Unit I	Soil Classification and Compaction	(7 Hrs)

Classification of Soil. HRB classification. Group Index Method. Compaction: Mechanics of compaction. Field-compaction equipment; their suitability and choice. Compaction quality control and measurement.

Unit II	Highway Drainage	(8 Hrs)

Subsoil drainage in Highway Engineering, Design of filters, perforated pipe drainage., Methods of sub soil drainage for roads, permeable blankets, longitudinal and transverse under drains, horizontal drains, stabilizing trenches. Sub soil drainage in highways, runways and railways.

Unit III	Shear Strength	(8 Hrs)
Shear Strength: Terzaghi's effective stress principle, effective shear parameters, measurement of pore pressures.		
Unit IV	**Stability and Earth Pressure**	**(7 Hrs)**
Stability Analysis of slopes: Factor of Safety, Stability of infinite slope, Stability of finite slope, Friction circle method, Taylor's Stability No. Earth Pressure Theories: Coloumb's Wedge Theory, Culman's method. Sheet pile walls and their analysis		
Unit V	**Ground Improvement Techniques**	**(8 Hrs)**
Different methods of soil stabilization, use of geosynthetics and fibers, etc. in the highway subgrade and highway construction, other ground improvement techniques (sand drains, band drains, stone columns, gabions, etc.) in the context of highway construction, reinforced earth.		
Unit VI	**Rock Engineering**	**(7 Hrs)**
Fundamental of rock Mechanics; Rock Properties; Rock Mass Classification Systems, Rock load classification according to Terzaghi, RQD index as a qualitative description of the rock mass, limitations, and advantages. Geomechanics Classification: General Comments on Application of Rock Mass Classification Schemes.		

Learning Resources

Textbooks:

1. Khanna, S.K., Justo, C.E.G. and Veeraraghavan, A *"Highway Engineering"* Nem Chand and Bros., Roorkee
2. P. R. Rethaliya *"Geotechnical Engineering"* Atul Prakashan
3. Sharma, S.K. *"Principles, Practice and Design of Highway Engineering"* S. Chand and Company Pvt. Ltd., New Delhi

Reference Books:

5. Rodriguez,A,R, Castillo del.h *"Soil Mechanics in Highway Engineering"* Trans Tech Publications
6. David McCarthy, "*Essentials of Soil Mechanics and Foundations"*, Pearson Education
7. R. Whitlow, *"3. Basic Soil Mechanics"*, Pearson Education.
8. Braja M. Das and Khaled Sobhan, "Principles of Geotechnical Engineering*"*, Cengage Publication

MOOC / NPTEL Courses for basic knowledge:

1. NPTEL Course "*Soil Mechanics/Geotechnical Engineering*", Prof. Dilip Kumar Baidya, IIT Kharagpur

Link **of the Course:**
https://onlinecourses.nptel.ac.in/noc23_ce84/preview#

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester II

Course Type: MMC	**Course Title**: IOT Basics and Applications	
Course Code: 230GETM16_02	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 2	**Lecture (L):** 1 **Tutorial (T):** 0 **Practical (P):** 2 **Experiential Learning (EL):** 0	**Practical (PR):** 50 marks **Oral (OR):** 50 marks

Prerequisite Courses, if any:

1. Basic Electronics
2. Basic Electrical engineering

Course Objectives:

- The knowledge and understanding of Internet of Things
- A strong foundation of fundamentals of Internet of Things and need of IoT Security
- Get acquainted with various communication protocols of Internet of Things
- Detailed understanding of present scope of Internet of Things with case studies

Course Outcomes: On completion of the course, learner will be able to

CO1: Understand various terms related to IOT.
CO2: Understand the working of IOT devices.
CO3: Identify different types of Sensors and actuators for IOT.
CO4: Understand working of sensors and actuators
CO5: Understand the concept of various IOT Protocols
CO6: Select sensors and actuators for industrial applications

Course Contents

Unit I	**IoT**	**(2 Hrs)**
Definition and characteristics of IoT, Internet of Things: Vision, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, Things of IoT, IoT Protocols, Logical design of IoT, IoT functional blocks, IoT communication models, IoT Communication APIs, IoT enabling technologies, IoT levels and deployment templates, IoT Issues and Challenges, Applications		
Unit II	**IoT Physical Devices and Endpoints**:	**(2 Hrs)**
Basic building blocks of and IoT device, Exemplary device: NodeMCU, Aurduino, and Other IoT Devices.		
Unit III	**Sensors**	**(2 Hrs)**
Roles of Sensors & Actuators, Types of sensors, Active and passive, analog and digital, Contact and no-contact, Absolute and relative		
Unit IV	**Working of Sensors**	**(3 Hrs)**
Position, occupancy and motion, velocity and acceleration, force, pressure, flow, Acoustic, Humidity, light, radiation, temperature, chemical, biosensor, camera. Development boards		
Unit V	**IoT Protocols**	**(2 Hrs)**

MQTT, CoAP, XMPP and AMQT, IoT communication models, IoT Communication technologies: Bluetooth, BLE, Zigbee, Zwave, NFC, RFID, LiFi, Wi-Fi, Interfacing of wifi, RFID, Zigbee,NFC with development board		
Unit VI	**Applications of IOT**	**(3 Hrs)**
Smart Home: Characteristics of Smart Home - Smart Home Energy Management, Smart Appliances, Communication Technologies for Smart Homes, maintenance, security, challenges. Smart Agricultural: characteristics and applications -Scarecrow, Smart Irrigation System, Crop Water Management, Integrated Pest Management, Sensor-based field and resource mapping, Remote equipment monitoring)		

Learning Resources

Text Books:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515 2. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012. ISBN : 9781439892992
2. Raj Kamal, Internet of Things: Architecture and Design Principle” , ISBN-13: 978-93-5260- 522-4, McGraw Hill Education (India) 2017

Reference Books:

1. The Internet of Things: From RFID to the Next-Generation Pervasive Networked Lu Yan, Yan Zhang, Laurence T. Yang, Huansheng Ning.
2. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally HakimaChouchi, “The Internet of Things Connecting Objects to the Web”, ISBN 078 -1- 84821-140-7, Wiley Publications Asoke K Talukder and Roopa R Yavagal, “Mobile Computing,” Tata McGraw Hill, 2010.

MOOC / NPTEL Courses:

1. https://onlinecourses.nptel.ac.in/noc22_cs53/preview
2. https://nptel.ac.in/courses/106105166

JSPM University Pune F.Y. M. Tech "Transportation Engineering" Semester II		
Course Type: MMC	**Lab Course Title**: IOT Basics and Applications	
Course Code: 230GETM16_02	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 2	**Lecture (L):** 1 **Tutorial (T):** 0 **Practical (P):** 2 **Experiential Learning (EL):**	**Practical (PR):** 50 marks **Oral (OR):** 50 marks
Prerequisite Courses, if any: -		

List of Laboratory Experiments	
Group A	
1.	Controlling GPIO pins in NodeMCU.
2.	LED blinking using Node MCU(Digital Write)
3.	Controlling LED using push button with NodeMCU (Digital Read)
4.	Temperature measurement using thermistor and NodeMCU Communication between Two NodeMCU using
5.	Smart lighting system using LDR and NodeMCU Study of smart material actuators.
Group B	
6.	Motion Detection using PIR Sensor and NodeMCU
7.	Gas detection using MQ135 and NodeMCU Experimental characterization of any one sensor.
8.	Servo motor (SG-90) control using NodeMCU Experimental characterization of DC motor
9.	Harmful gas monitoring using NodeMCU and ThingSpeak
Group C	
10.	Designing Weather station by HTTP GET REQUEST-RESPONSE using NodeMCU
11.	Design based experiment aiming selection of sensors for industrial application.

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester II

Course Type: SEC	**Course Title:** Building Information Modelling	
Course Code: 230GSEM19_01	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 3	**Lecture (L):** 2 **Tutorial (T):** 0 **Practical (P):** 2 **Experiential Learning (EL):** 0	**Practical (PR):** 50 marks **Oral (OR):** 50 marks

Prerequisite Courses, if any:

1. Basic AutoCAD

Course Objectives:

- Familiarize students with the basic principles of Building Information Modeling (BIM) and the BIM cycle.
- Develop the skills to draw and modify fundamental building elements such as walls, windows, doors, and floors.
- Enable students to utilize advanced modification tools for efficient design adjustments.
- Provide in-depth knowledge of annotations, dimensions, and openings in architectural designs.
- Introduce students to visualization and rendering techniques for both interior and exterior.
- Guide students in developing a complete architectural project using all the learned tools and commands.

Course Outcomes: On completion of the course, learner will be able to…

CO1: Demonstrate proficiency in navigating the user interface, creating building elements, defining project units, and understanding file types within the BIM context.
CO2: Create detailed building plans, manipulate wall structures, and efficiently use commands for elements like windows, doors, and roofs.
CO3: Demonstrate proficiency in using tools like array, mirror, split, and align, facilitating precise modifications and enhancements in architectural designs.
CO4: Create and manage annotations effectively, including dimensions, and various types of openings in walls.
CO5: Create realistic images.
CO6: Demonstrate comprehensive knowledge and application of Revit Architecture software

Course Contents		
Unit I	**Introduction to BIM and Building commands**	**(6Hrs)**
Introduction to BIM: Explaining basics about the (BIM) cycle and the basic information, Exploring User Interface, Building Elements, Project Units, Visual Styles, File types Creating Levels & Level Family, Grid creation, modifications for level and grid. **Building Command:** Draw walls - Location line, draw wall shapes Drawing a plan as per Dimension Creating wall Structure Modify wall- Split Region, Sweep and Reveals Walls shapes and Openings Draw Windows & Doors, Family and edit type Create Floor & Floor Properties, Slab Edges, Place Components-Furniture Roof-by Footprint, by Extrusion, soffit, fascia, gutter Join/Unjoin Roof.		
Unit II	**Building architectural drawing**	**(5Hrs)**
Creating Curtain Wall, Curtain Grid, Mullions, Adding Curtain Door Panel, Embedded walls Practice with project. Dimensions, Temporary Dimensions, Dimension settings by edit type Permanent Dimensions, creating ceiling, Opening-wall, face and vertical opening, Shaft and Dormer.		
Unit III	**Modify commands & View**	**(6Hrs)**
Modify Tools: Join and cut geometry. Move, Copy, Paste, Rotate, Mirror, Array, Scale, Split Element, Trim, Align, Offset, Delete, Match Type, Tape Measure, filter, paint, match properties, keyboard shortcuts for all. **View:** Elevation view, Section view,3D views, view range, section box, visibility graphics hatching Area, Colour Schemes, Keynotes, Text, Model text, Tag, Callout Views, Drafting Views.		
Unit IV	**Circulation, Massing and Site**	**(5Hrs)**
Circulation: Stairs-Creating Stairs, creating stair by Sketching Runs. Creating stair by sketching Boundary and Riser, Spiral Staircase. Annotations for all related tools. Ramp, Railings and Rail Family, Modifying Rail Structure, Custom baluster, Staircase joints. Complete one project using all tools. **Massing and Site:** Create Mass Family using forms, Introduction Extrusion, Loft, Sweep blend, sweep Creating Building Elements from Mass Instance, Model-in-place, Mass Floors, creating wall, Floors, Roof and curtain system, Building pad, Graded Region, Parking, Topo surface Components, sub region, split surface, contour labels.		
Unit V	**Sheet Composition and Rendering**	**(5Hrs)**
Sheet Composition: Schedule/Quantities Material Take Off Legend Creation Sheets-Title Blocks, Views on sheet, Print settings. **Rendering and Walkthrough:** Lights-Adding Light Fixtures, Exterior Lighting-Solar Studies, sun setting, Camera and Walkthrough, Decal images, Exporting Walkthrough, Rendering, settings, customization, adjust exposure, Create realistic images for exterior and interior.		
Unit VI	**Design and Insert Option and Family creation**	**(3Hrs)**
Design option, Export to CAD format Family Creation- Door, Window, Project of interior view		

Learning Resources
Text Books: 1. ASCENT, "*Autodesk Revit 2024 Architecture Fundamental*", SDC Publication. 2. Daniel John Stine AIA, "*Interior Design Using Autodesk Revit 2014*", SDC Publication.
Reference Books: 1. Autodesk, "Autodesk Revit User Manual", Autodesk
MOOC / NPTEL Courses: 1. https://nptel.ac.in/courses/112102101 2. https://www.youtube.com/playlist?list=PLMtzJAOD3B7YpZpVB17IFAFQG6Nqij-mY

JSPM University Pune F.Y. M. Tech "Transportation Engineering" Semester II		
Course Type: SEC	**Course Title:** Building Information Modelling	
Course Code: 230GSEM19_01	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 3	**Lecture (L):** 2 **Tutorial (T):** 0 **Practical (P):** 2 **Experiential Learning (EL):** 0	**Practical (PR):** 50 marks **Oral (OR):** 50 marks
Prerequisite Courses, if any: -		
List of Laboratory Experiments		
Group A		
1.	Hands on practice on Revit Architecture user interface	
2.	Practicing for creating walls, doors, and windows	
3.	Creating curtain walls and opening in the walls	
4.	Creating floors and roofs.	
5.	Modifying objects	
Group B		
6.	Creating dormer windows and stairs.	
7.	Hands on practice on View and Area command	
8.	Creating mass family	
9.	Sheet compositions	
Group C		
10.	Rendering and Walkthrough	

JSPM University Pune F.Y. M. Tech "Transportation Engineering" Semester II		
Course Type: VSC	**Course Title:** Innovation	
Course Code: 230IINB02_02	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 1.5	**Lecture (L):** 1 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 2	**Oral (OR):** 50 Marks
Prerequisite Courses, if any: -		
Course Objectives: • To understand the concept of innovation and creativity • To familiarize with the tools for innovation • To understand fundamentals of innovation management • To get overview of real-world implementation of innovation and creativity		
Course Outcomes: On completion of the course, learner will be able to **CO1:** apply the concepts of creativity and innovation in all walks of life. **CO2:** inculcate and incorporate individual creativity and innovative skill set at conceptual, product design and management level. **CO3:** solve real time problems with enhanced ability in respective sectors of work for increased productivity and improved organizational behaviour. **CO4:** perform with improved skill set in entrepreneurship and start up ecosystem. **CO5:** to find solutions to social, corporate and personal problems with de novo approach.		
Course Contents		
Unit I	**Innovation & Creativity**	**(3Hrs)**
Innovation: Meaning, Concept, Characteristics, Importance, Principles of Innovation, Process of Innovation. **Creativity:** Meaning, Concept, Importance, Creativity Process, Components of creative performance, Hurdles to Creativity		
Unit II	**Tools for Innovation**	**(5Hrs)**

Creative Thinking: Traditional V/S Creative Thinking,
Individual Creativity Techniques: Meditation, Self-Awareness, & Creative Focus
Group Creative Techniques: Brainstorming, Off the Wall Thinking &Thinking Hats Method.
Dimensions of Innovation:
Innovation Eco-system in India and abroad, Social Innovation, Grass root Innovation, Frugal Innovation, Global Innovation- Global Innovation Index framework, GII, Case studies in India and abroad.

Unit III	**Innovation Management**	**(3Hrs)**

Concept, Scope, Characteristics, Evolution of Innovation Management, Significance, Factors Influencing Innovation, Commercialization of Innovation, Innovation and Start up ecosystem

Unit IV	**Areas of Innovation**	**(2Hrs)**

Innovation in Entrepreneurship, Product innovation, Process Innovation, Social Innovation, Case studies highlighting types, implementation imperatives and sector specific impact.

Unit V	**Group innovation study**	**(1Hrs)**

Each student group will prepare a case study on one innovation topic either from their area of work or through participation in the exposition, symposia, workshop of any relevant forum. The project report will be submitted for the study.

Unit VI	**Presentation and Closure**	**(1Hrs)**

The student group will give the presentation of the project in the chosen area. The report will highlight the process of exploring executing and exploiting the innovation. It will also mention methodology to manage the innovation.

Learning Resources

Text Books:

1.Wagner, Tony. Creating Innovators: The Making of Young People Who Will Change the World. New York: Scribner, 2012.
2. “Managing Creativity and Innovation” Harvard Business School Press

Reference Books:

1. “Organizational Innovation”, SAGE Publication, London, 2001.
2. “Jugaad Innovations, Navi Radjou and Jaideep Prabhu, Random House India
3. “Kelley, Tom, Jonathan Littman, and Tom Peters. The Art of Innovation: Lessons in Creativity from IDEO, America’s Leading Design Firm. New York: Doubleday, 2001.
4. “Innovation Management & New Product Development”, Paul Trott, published by Pitman, 2000.

MOOC / NPTEL Courses:

1. NPTEL Course "*Innovation, Business Models and Entrepreneurship",* Prof Rajat Agrawal, Prof Vinay Sharma, IIT Roorkee.
   Link of the Course: https://onlinecourses.nptel.ac.in/noc23_mg116/preview

Additional Web Resources:

https://youtu.be/FXJUDyqobbM
https://youtu.be/FF_38_ZuRbQ
https://youtu.be/33JjV_NDbpY
https://youtu.be/DNUwZctwwhw
https://youtu.be/_PC1qbAhKz0
https://youtu.be/wbFVNBNI7Bk
https://youtu.be/kfpERveB8kM
https://youtu.be/Y6R9ps2E1oM
https://youtu.be/66N5SM73AEc
https://youtu.be/1YLtkc6U3Rs

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester II

Course Type: AEC	**Course Title:** Business Communication	
Course Code: 231UENM02_02	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 2	**Lecture (L):** 1 **Tutorial (T):** 0 **Practical (P):** 2 **Experiential Learning (EL):** 0	**(Practical):** 50 Marks

Prerequisite Courses, if any: Nil

Course Objectives:

- Remember the theoretical basics of Communication.
- Understand skills required for efficient interpersonal communication and leadership abilities.
- Apply Presentation Techniques in the Professional Environment.
- Analyze trends in the respective market to accommodate accordingly.
- Evaluate the skills related to production & presentation of messages in multiple formats.

Create placement ready personalities

Course Outcomes:

On completion of the course, learner will be able to

CO1: Apply Verbal and Non-Verbal Communication Techniques in the Professional Environment

CO2: write impressive official correspondence and learn to make and give effective presentations in a professional environment.

CO 3: Write an impressive resume and face the interview confidently.

CO 4: Present themselves well in front of large audience on a variety of situations related to group communication and presentation in a relevant scenario.

CO5: Socialize with ease and comfort.

CO6: Develop Corporate Communication Skills.

Course Contents

Unit I	**Employment Communication**	**(2 Hrs)**

Introduction and objectives of Report Writing, Types of Business Reports-Informational Reports, Analytical Report, Research Report, Progress Report, Explanatory Report, Structure of Reports- Title page, table of content, summary, the main body, conclusion, and recommendations, Writing Abstracts and Summaries

Unit II	**Resume Writing**	**(2 Hrs)**

Introduction to Resume Writing- Concept and Details, Types of Resume Writing- chronological and functional, Key components of effective Resume Writing, Structure and contents of Cover Letter

Unit III	Interview Skills / Techniques	(3 Hrs)
Interview Skills / Techniques – Concept and Process, Peer Interview/Mock Interview- Pre-interview planning and performance, Opening Strategies and Answering Strategies, Interview through tele and video- conferencing		
Unit IV	**Group Discussion**	**(3 Hrs)**
Group Discussion – Concept and important points, Roles and Phases in Structured Group Discussion, Expectations of the Panel, Do's and Don'ts in Group Discussion Group Discussion – Concept and important points, Roles and Phases in Structured Group Discussion, Expectations of the Panel, Do's and Don'ts in Group Discussion		
Unit V	**Presentation Skills**	**(2 Hrs)**
Elements of Presentation- Content, Organization, Delivery, Design of Presentation- Typography, colour, layout, images and animation, Oral Presentations (individual or group) through JAM Sessions/Seminars/PPTs, Written Presentations through Posters/Projects/Reports/ E-mails/Assignments		
Unit VI	**Essential Soft Skills**	**(3 Hrs)**
Soft Skills development- Grooming Etiquettes and Manners, Stress and Conflict Management- Coping styles and symptoms, Time Management- Pomodoro Technique, Pareto Technique, Leadership Skills- Definition, Strategies, and Styles		

Learning Resources

Textbooks:

Bovee, Courtland L, John V. Thill & Barbara E. Schatzman. *Business Communication Today*: Tenth Edition. New Jersey: Prentice Hall, 2010.

Reference Books:

1. Collins, Patrick. *Speak with Power and Confidence*. New York: Sterling, 2009.
2. Barun, Mitra. Personality Development and Soft Skills, Barun K Mitra, Oxford Press, 2011.

MOOC / NPTEL Courses:

1. NPTEL Course "Soft skill Development" Prof. Priyadarshi Patnayak, Prof. V.N, Giri, Prof. D. Suar, IIT Kharagpur

Link of the course: https://youtu.be/Af9RoDvhTLE?si=cqQim2DX2Cepi0eX

Additional Web Resources:

http://www.englishdaily626.com/c-errors.php
https://www.stressdirections.com/personal/about_stress/stress_statistics.html

JSPM University Pune F.Y. M. Tech "Transportation Engineering" Semester II		
Course Type: AEC	**Lab Course Title:** Business Communication	
Course Code: 231UENM02_02	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 2	**Lecture (L):** 1 **Tutorial (T):** 0 **Practical(P):** 2 **Experiential Learning (EL):** 0	**Theory (TH):** 50 Marks
Prerequisite Courses, if any: -		

List of Lab Activities	
Group A	
1.	Report Writing
2.	Resume Writing
3.	Interview technique
4.	Group Discussion
5.	Presentation Skills
Group B	
6.	Soft Skills: Grooming, Etiquettes and Manners
7.	Stress Management
8.	Time Management
9.	Leadership Skill
10.	PowerPoint Presentation

JSPM University Pune
F.Y. M. Tech "Transportation Engineering"
Semester II

Course Type: RMC	**Course Title:** Research Design and Techniques	
Course Code: 230IRMM02_02	**Teaching Scheme:** (Hrs. / Week)	**Examination Scheme:**
Credits: 2	**Lecture (L):** 2 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 50 Marks

Prerequisite Courses, if any: -

Course Objectives:

- To develop the ability to create visual representations of data using appropriate tools
- To equip with various statistical techniques to draw meaningful conclusions from data
- To enable the students with the principles of experimental design, the formulation and execution of experiments
- To enable students to comprehend the concept of Analysis of Variance, and different types of ANOVA
- To develop proficiency in selecting and applying appropriate measures of association
- To acquaint students with the process of crafting research proposals

Course Outcomes: On completion of the course, learner will be able to

CO1: Demonstrate Proficiency in Data Visualization Techniques
CO2: Perform data analysis using statistical methods
CO3: Apply of Experimental Design Principles in various research contexts
CO4: Interpret research data using Analysis of Variance (ANOVA)
CO5: Demonstrate Proficiency in Measuring Associations
CO6: Develop Comprehensive Research Proposal

Course Contents

Unit I	**Data Visualization**	**5 Hrs**
Data preparation process, data presentation, data visualization techniques, effective communication of complex findings		
Unit II	**Data Analysis**	**5 Hrs**
Basic statistical concepts, measure of central tendency and variation, univariate statistics, sampling distribution, hypothesis testing		
Unit III	**Design of Experiments**	**5 Hrs**
Basics of experimental design, principles of randomization, factorial experiments, fractional		

factorial designs, Design of Experiments (DOE)		
Unit IV	**ANOVA**	**5 Hrs**
Introduction to ANOVA, One-way ANOVA, Two – way ANOVA, Analysis of Covariance (ANCOVA)		
Unit V	**Measures of Association**	**5 Hrs**
Simple regression, Multiple Regression, Chi square tests, Equality of proportion test		
Unit VI	**Research Proposal Development**	**5 Hrs**
Importance of research proposals in academic and professional contexts, Components of a research proposal, creating a realistic research timeline, Submitting the research proposal for funding or approval, Research proposal drafts and peer reviews		

Learning Resources

Text Books:

2. Wayne Goddard, Stuart Melville, "*Research Methodology: An Introduction*", Juta, Lansdowne, Second Edition.
3. Ranjit Kumar "*Research Methodology*: A Step-by-Step Guide for Beginners", SAGE Publications Pvt. Ltd Fourth Edition.
4. Dr. C. R. Kothari, "*Research Methodology: Methods and Trends*", New Age International (P) Limited, Publishers, Second Edition.

Reference Books:

9. Nicholas Walliman, *"Research Methods: The Basics",* Routledge – Taylor and Francis Group, Third Edition.
10. Vinod Chandra, Anand, Hareendran "Research Methodology", Pearson 1st Edition
11. Dr. Prabhat Pandey, Dr. Meenu Mishra Pandey, "Research Methodology: Tools and Techniques", Bridge Center, 2015.
12. Alan Bryman & Emma Bell, "*Business Research Methods*", Oxford University Press, Third Edition.

MOOC / NPTEL Courses:

1. "*Research Methodology*", Prof. Edamana Prasad, Prof. Prathap Haridoss, IIT Madras.
   Link of the Course: https://onlinecourses.nptel.ac.in/noc23_ge36/preview
2. "*Research Methodology*", Prof. Soumitra Banerjee, IISER Kolkata.
   Link of the Course: https://archive.nptel.ac.in/courses/127/106/127106227/

Additional Web Resources:

1. https://www.coursera.org/specializations/data-collection
2. https://www.coursera.org/learn/anova-and-experimental-design
3. https://www.coursera.org/learn/research-proposal-initiating-research

JSPM University Pune F.Y. M. Tech "Transportation Engineering" Semester II		
Course Type:	**Lab Course Title:** Traffic and Pavement Engineering lab	
Course Code: 230GTEM21_02	**Teaching Scheme:**	**Examination Scheme:**
Credits: 1	**Lecture (L):** **Tutorial (T):** **Practical (P): 2** **Experiential Learning (EL):**	**Practical: 50**
Prerequisite Courses, if any: -		

List of Laboratory Experiments	
Group A Test on Bituminous material	
1.	Specific gravity of bituminous materials
2.	Penetration Test
3.	Softening Point Test
4.	Ductility Test
5.	Flash and fire point test
6.	Thin film oven Test
7.	Viscosity test
Group B Test of bitumen mix design	
8.	Marshall Mix design,
9.	Bitumen content determination using centrifuge extractor.
10.	Stripping value of aggregate
Group C Test on traffic studies	
11.	Traffic saturation flow

Virtual LAB Links:

1. Lab Name: Transportation Engineering
   Link of the Virtual Lab: https://ts-nitk.vlabs.ac.in/

JSPM University Pune F.Y. M. Tech "Transportation Engineering" Semester II		
Course Type: IITP / FP/CEP	**Lab Course Title:** Internship / Field Projects/ Community Engagement project	
Course Code: 230GTEM22_02	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 2	**Duration:** 04 to 06 Weeks	**Oral (OR):** 50 Marks
Prerequisite Courses, if any: -		

Objectives:

- To expose students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations.
- To provide students with an opportunity to apply theoretical knowledge from academics to the realities of the field work/training.
- To providing practical experience in a field or discipline

Course Outcomes: On completion of the course, learner will be able to

CO1: Develop professional competence through internship.

CO2: Apply academic knowledge in a personal and professional environment.

CO3: Build the professional network and expose students to future employees.

CO4: Apply professional and societal ethics in their day to day life.

CO5: Become a responsible professional having social, economic and administrative considerations.

CO6: Decide own career goals and personal aspirations.

Duration and Evaluation:

- Internship to be completed after every even semester (2, 4 and 6) and before commencement of next odd semester (03, 05 and 07).
- Internship should be at least 4 to 6 weeks and it is to be assessed immediately after completion.

Framework of Internship/ Field Project / Community Engagement Project:

- During the vacation after even semester, students are ready for industrial experience. Therefore, they may choose to undergo Internship / Field Project / Community Engagement Project

- Students may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry.
- Every student is required to prepare a file containing documentary proofs of the activities done by him.
- The evaluation of these activities will be done by Programme Coordinator/ Project Head / faculty / TPO/ mentor or Industry Supervisor.

Internship Guidelines:

Step 1: The department will issue request Letter/ Email to the respective industry/ firm/ NGO/ organization to allot various slots of 4-6 weeks as internship**/** Field Project / Community Engagement Project periods for the students.

Step 2: Industry will confirm the training slots allocated for internships via Confirmation Letter/ Email.

Step 3: Students on joining Training at the concerned Industry / Organization, submit the Joining Report/ Letters / Email.

Step 4: Students undergo industrial training/ Field Project / Community Engagement Project at the concerned Industry / Organization. In- between Faculty Member(s) can evaluate(s) the performance of students once/twice by visiting the Industry/Organization and Evaluation Report of the students is submitted in department.

Step 5: Students will submit training report after completion of internship.

Step 6: Training Certificate to be obtained from industry / Organization.

Internal Reporting Guidelines for students:

- Every intern should send weekly report to their internal guide without fail. It is mandatory for the intern to send weekly reports to their respective guide on regular basis.
- Interns should have at least fortnightly verbal communication with the internal guide without fail.
- In cases where in the company wants to secure their confidential information in the project / internship report, the internal guide should duly co-ordinate with the respective mentor/reporting manager on the method of reporting to assure that no information will be leaked outside and is purely for academic purposes.

Internship Diary / Internship Workbook:

- Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documenting. The students

should record in the daily training diary account of the observations, impressions, information gathered and suggestions given, if any.

- The training diary/workbook should be signed after every day by the supervisor/ in charge of the section where the student has been working.
- Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.

Internship Diary / workbook may be evaluated on the basis of the following criteria:

- Proper and timely documented entries.
- Adequacy & quality of information recorded
- Data recorded.
- Thought process and recording techniques used.
- Organization of the information.

Internship Work Evaluation:

- Every student is required to prepare and maintain documentary proofs of the activities done by him / her as internship diary or as workbook.
- The evaluation of these activities will be done by Programme Coordinator/ Project Head / faculty / TPO/ mentor or Industry Supervisor based on- overall compilation of internship activities, sub-activities, the level of achievement expected, evidence needed to assign the points and the duration for certain activities.

Evaluation-Seminar presentation / Oral Examination at the institute:

The student will present a seminar based on his training report, before an expert committee constituted by the concerned department as per norms.

The evaluation will be based on the following criteria:

- Depth of knowledge and skills Communication & Presentation Skills.
- Team Work
- Creativity
- Planning & Organizational skills
- Adaptability and Analytical Skills
- Attitude & behaviour at work.
- Societal Understanding
- Ethics
- Regularity and punctuality
- Attendance record
- Log book
- Student's Feedback from External Internship Supervisor

- **Internship Report:**
- The report shall be presented covering following recommended fields but limited to:
- Title/Cover Page
- Internship completion certificate.

- Internship Place Details- Company background-organization and activities/Scope and
- object of the study / personal observation.
- Index/Table of Contents
- Introduction
- Title/Problem statement/objectives
- Motivation/Scope and rationale of the study
- Methodological details
- Results / Analysis /inferences and conclusion
- Suggestions / Recommendations for improvement to industry, if any
- Attendance Record
- List of reference (Library books, magazines and other sources)

Feedback from internship supervisor (External & Internal):

Post internship, faculty coordinator should collect feedback about student with following recommended parameters:

- Technical knowledge
- Discipline
- Punctuality
- Commitment
- Willingness to do the work
- Communication skill
- Individual work
- Team work
- Leadership

JSPM University Pune

Faculty of Science and Technology

School of Civil and Environmental Sciences

NEP aligned Syllabus

for

SY M. Tech (Transportation Engineering)

(Effective from AY: 2025-26)

	JSPM University Pune	COURSE STRUCTURE (NEP 2020 Aligned)	
	FACULTY OF SCIENCE & TECHNOLOGY	W. E. F	2025-2026
	SCHOOL OF CIVIL AND ENVIRONMENTAL SCIENCES	RELEASE DATE	01/07/2025
	SECOND YEAR MASTER OF TECHNOLOGY (TRANSPORTATION ENGINEERING)	REVISION NO.	0.0 (NEP)

SEMESTER III (LEVEL 7)

COURSE			TEACHING SCHEME				EXAMINATION SCHEME AND MARKS									
			Hours / Week				THEORY (Equal Weightage for CIE and ESE)				PRACTICAL (Equal Weightage for CIE and ESE)		ORAL (Equal Weightage for CIE and ESE)		TOTAL	CREDITS
TYPE	CODE	COURSE NAME	L	T	P	EL	CONTINUOUS INSEMESTER EVALUATION (100 Marks)			END SEMESTER EXAMINATION (100 / 50 Marks)	CONTINUOUS INSEMESTER EVALUATION (50 Marks)	END SEMESTER EXAMINATION (50 Marks)	CONTINUOUS INSEMESTER EVALUATION (50 Marks)	END SEMESTER EXAMINATION (50 Marks)		
							T1 (30 Marks)	T2 (30 Marks)	Assign-ments (40 Marks)							
PEC	-	Program Elective-I / MOOCs	3	-	-	-	30	30	40	100	-	-	-	-	100	3
PEC	-	Program Elective-II / MOOCs	3	-	-	-	30	30	40	100	-	-	-	-	100	3
IOC	-	Interdisciplinary Open Course -I	2	-	-	-	30	30	40	100	-	-	-	-	100	2
IOC	-	Interdisciplinary Open Course -II	2	-	-	-	30	30	40	100	-	-	-	-	100	2
VEC	230USYB01_03	Behavioral Science and Ethics	2	-	-	-	30	30	40	50	-	-	-	-	50	2
SLC	240GTEM03_03	Seminar	-	-	-	8	-	-	-	-	-	-	50	50	50	2
PROJ	240GTEM01_03	Field Project	-	-	4	8	-	-	-	-	50	50	50	50	100	4
TOTAL			12	0	8	8									**600**	**18**
MLC#	230GSEM29_04	Audit Course - I	1	-	-	-	-	-	-	50	-	-	-	-	50	1

Sem.	Interdisciplinary Open Course (IOC)		
	Specialization	**(IOC – I)**	**(IOC – II)**
III	**Course Code**	250GCSM03_03	230GCSM33_03
	Course Name	Fundamentals of Artificial Intelligence and Machine Learning	Introduction to Python Programming
III	**Course Code**	230VMSM11_03	230VBCB04_03
	Course Name	Fundamentals of Financial Management	Basics of Accounting

Sem.	Programme Elective Course (PEC)			
	Specialization	**Transportation Engineering**		
III (PEC – I)	**Course Code**	230GTEM07_03	230GTEM08_03	230GTEM09_03
	Course Name	Mass Transit System	Urban Public Transport	Highway Planning and Economic Development
III (PEC – II)	**Course Code**	230GTEM10_03	230GTEM11_03	230GTEM12_03
	Course Name	Road Safety and Road Safety Audit	Airport, Railway, Docks, and Harbor Engineering	Intelligent Transport Systems
IV (PEC – III)	**Course Code**	230GTEM13_04	230GSEM15_04	230GTEM15_04
	Course Name	Safety in Highways and Airports	Advanced Concrete Technology and Applications	Ground Improvement Techniques
IV (PEC – IV)	**Course Code**	230GTEM16_04	230GTEM17_04	230GTEM18_04
	Course Name	Sustainable Construction and Lean Construction	Pavement Recycling	Design of Highway Geometrics and Drainage

Sem.	Mandatory Learning Course (MLC#) - Audit Course	
III (Audit Course - I)	**Course Code**	230GSEM29_03
	Course Name	Structural Audit
IV (Audit Course - II)	**Course Code**	230UPOB02_04
	Course Name	Introduction to Indian Constitution

Dr. Prashant Sudani
Programme Coordinator, MTech- TRE

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Dr. Anuradha S. Deshpande
Associate Dean (Academics)

Prof. B.B. Ahuja
Vice Chancellor, JSPM University Pune

	JSPM University Pune	COURSE STRUCTURE (NEP 2020 Aligned)	
	FACULTY OF SCIENCE & TECHNOLOGY	W. E. F	2025-2026
	SCHOOL OF CIVIL AND ENVIRONMENTAL SCIENCES	RELEASE DATE	01/07/2025
	SECOND YEAR MASTER OF TECHNOLOGY (TRANSPORTATION ENGINEERING)	REVISION NO.	0.0 (NEP)

SEMESTER IV (LEVEL 7)

COURSE			TEACHING SCHEME				EXAMINATION SCHEME AND MARKS									
			Hours / Week				THEORY (Equal Weightage for CIE and ESE)				PRACTICAL (Equal Weightage for CIE and ESE)		ORAL (Equal Weightage for CIE and ESE)		TOTAL	CREDITS
TYPE	CODE	COURSE NAME	L	T	P	EL	CONTINUOUS INSEMESTER EVALUATION (100 Marks)			END SEMESTER EXAMINATION (100 / 50 Marks)	CONTINUOUS INSEMESTER EVALUATION (50 Marks)	END SEMESTER EXAMINATION (50 Marks)	CONTINUOUS INSEMESTER EVALUATION (50 Marks)	END SEMESTER EXAMINATION (50 Marks)		
							T1 (30 Marks)	T2 (30 Marks)	Assign-ments (40 Marks)							
PEC	-	Program Elective-III/ MOOCs	3	-	-	-	30	30	40	100	-	-	-	-	100	3
PEC	-	Program Elective-IV/ MOOCs	3	-	-	-	30	30	40	100	-	-	-	-	100	3
PROJ	240GTEM02_04	Project / Internship with Project	-	-	12	24	-	-	-	-	200	200	100	100	300	12
TOTAL			6	0	12	24									**500**	**18**
MLC#	230UPOB02_04	Audit Course - II	1	-	-	-	-	-	-	50	-	-	-	-	50	1

Sem.	Interdisciplinary Open Course (IOC)		
	Specialization	**(IOC – I)**	**(IOC – II)**
III	**Course Code**	250GCSM03_03	230GCSM33_03
	Course Name	Fundamentals of Artificial Intelligence and Machine Learning	Introduction to Python Programming
III	**Course Code**	230VMSM11_03	230VBCB04_03
	Course Name	Fundamentals of Financial Management	Basics of Accounting

Sem.	Programme Elective Course (PEC)			
	Specialization	**Transportation Engineering**		
III (PEC – I)	**Course Code**	230GTEM07_03	230GTEM08_03	230GTEM09_03
	Course Name	Mass Transit System	Urban Public Transport	Highway Planning and Economic Development
III (PEC – II)	**Course Code**	230GTEM10_03	230GTEM11_03	230GTEM12_03
	Course Name	Road Safety and Road Safety Audit	Airport, Railway, Docks, and Harbor Engineering	Intelligent Transport Systems
IV (PEC – III)	**Course Code**	230GTEM13_04	230GSEM15_04	230GTEM15_04
	Course Name	Safety in Highways and Airports	Advanced Concrete Technology and Applications	Ground Improvement Techniques
IV (PEC – IV)	**Course Code**	230GTEM16_04	230GTEM17_04	230GTEM18_04
	Course Name	Sustainable Construction and Lean Construction	Pavement Recycling	Design of Highway Geometrics and Drainage

Sem.	Mandatory Learning Course (MLC#) - Audit Course	
III (Audit Course - I)	**Course Code**	230GSEM29_03
	Course Name	Structural Audit
IV (Audit Course - II)	**Course Code**	230UPOB02_04
	Course Name	Introduction to Indian Constitution

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Vice Chancellor, JSPM University Pune

JSPM University Pune S.Y. M. Tech "Transportation Engineering" Semester III		
Course Type: PEC	**Course Title:** Mass Transit System	
Course Code: 230GTEM07_03	**Teaching Scheme:**	**Examination Scheme:**
Credits: 3.0	**Lecture (L): 03** **Tutorial (T): --** **Practical (P): --** **Experiential Learning (EL): 00**	**CIE: 100 Marks** **ESE: 100 Marks**

Prerequisite Courses, if any:

1. Traffic Engineering

Course Objective:

- To introduce students to various types of transit systems, their evolution, and operational features relevant to urban transportation.
- To understand the techniques and behavioral aspects associated with transit demand estimation.
- To study and apply principles of transit service design and evaluate system capacity requirements.
- To equip students with knowledge and tools for efficient transit route and network planning.
- To develop skills in scheduling and resource management for effective transit operations.
- To introduce planning approaches for transit corridors and terminals, along with system performance evaluation techniques.

Course Outcomes: On completion of the course, learner will be able to

CO1: Differentiate between transit modes and evaluate their operational characteristics and suitability for different urban contexts.

CO2: Analyze transit travel demand and user behavior, and apply mode split and patronage estimation methods.

CO3: Design bus and rail operations and assess transit system capacity and service levels.

CO4: Plan, evaluate, and optimize transit route networks based on spatial and demand characteristics.

CO5: Develop optimal transit schedules and determine fleet and depot requirements for various service patterns.

CO6: Plan transit corridors and terminals and evaluate system performance using standard metrics and techniques.

Course Contents

Unit I	**Introduction to Transit Systems**	**(8 Hrs)**

History of urban growth and transit evolution, Types of transit modes: Buses, LRT, RTS, Para-transit, Operational characteristics: speed, capacity, payloads, Criteria for transit system selection.		
Unit II	**Transit Demand Estimation and Rider Behaviour**	**(7 Hrs)**
Data requirements and collection techniques, Destination, stop, and ride surveys, Mode split models, Captive vs. choice riders, Traveller attitudes and patronage estimation.		
Unit III	**Transit System Design and Capacity**	**(8 Hrs)**
Frequency and headway calculations, Rail and bus operation design, Way and station capacity, Transit level of service, Platform capacity.		
Unit IV	**Route and Network Planning**	**(7 Hrs)**
Route location, structure, and coding, Transit network planning and evaluation, Service area coverage, Optimal network selection and path building, Integration with UTPS.		
Unit V	**Transit Scheduling and Operations Management**	**(8 Hrs)**
Patterns of transit service, Scheduling of single route buses, Fleet requirement and marginal ridership, Optimization techniques, Load factor, depot location, bus stop spacing.		
Unit VI	**Transit Corridor and Terminal Planning**	**(7 Hrs)**
Corridor identification and compression methods, Rapid Transit System planning and system selection, Aesthetics, noise, fare structure, transit marketing, Terminal planning and performance evaluation, System efficiency, productivity, utilization.		

Learning Resources

Textbooks:

1. Black, Alan, Urban Mass Transportation Planning, McGraw- Hill,Inc., New York,1995.
2. Papacostas C.S. and Prevedouros, P.D., Transportation Engineering & Planning, PHI, New Delhi,2002
3. David A. Hensher, Bus Transport: Economics, Policy and Planning. Research in Transportation Economics Volume 18. Elsevier Publications, 2007.

Reference Books:

1. Ceder, A.,Public Transit Planning and Operation: Theory, Modeling and Practice, B-H Elsevier Ltd., MA, 2007.
2. Tiwari G., Urban Transport for Growing Cities – High Capacity Bus System, MacMillan India Ltd., 2002
3. Transit Capacity and Quality of Service Manual, Third Edition, Transit Cooperative Research Program (TCRP) Report 165: Transport Research Board, 2013.

MOOC / NPTEL Courses for basic knowledge:

1. NPTEL Course "*Introduction to Multimodal Urban Transportation Systems (MUTS)*", Prof. Arkopal Kishore Goswami, IIT Kharagpur

Link of the Course: https://onlinecourses.nptel.ac.in/noc21_ce72/preview

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester III

Course Type: PEC I	**Course Title:** Urban Public Transport	
Course Code: 230GTEM08_03	**Teaching Scheme:**	**Examination Scheme:**
Credits: 3.0	**Lecture (L): 03** **Tutorial (T): --** **Practical (P): --** **Experiential Learning (EL): 00**	**CIE: 100 Marks** **ESE: 100 Marks**

Prerequisite Courses, if any:

1. Traffic Engineering

Course Objective:

- To understand urban public transportation options and recommend suitable modes for specific situations.
- To analyze economic factors among transport modes and determine the most efficient and cost-effective option.
- To develop strategies for effective management of public transport systems.
- To understand system parameters to assess performance, including routes, junctions, and stations.
- To forecast future transportation needs and plan for system requirements accordingly.
- To understand the dynamics of goods transportation in urban environments.

Course Outcomes: On completion of the course, learner will be able to

CO1: Understand the various options for urban public transportation and recommend suitable mode for the given situation.

CO2: Conduct economic analysis between different transport modes and suggest most economical and efficient mode under the given set of conditions.

CO3: Understand the management of public transport system and developing strategies for efficient functioning of the system.

CO4: Carry out the evaluation of capacities of the system parameters such as routes, junctions, stations etc, to know the performance of the system.

CO5: Forecast the future transportation needs and variations in system components so as to plan for the transportation system requirements.

CO6: Demonstrate knowledge of goods transportation dynamics in urban environments.

Course Contents

Unit I	**System and Technologies**	**(7 Hrs)**

System and Technologies: Urban passenger transportation modes, transit classifications and definitions, theory of urban Passenger transport modes, rail transit, bus transit, Metro and Mono Rail, Para transit and ride sharing, designing for pedestrians, trends in transit ridership.

Unit II	**Comparing Alternatives**	**(8 Hrs)**

Comparing Alternatives: Comparing costs, comparative analysis, operational and technological characteristics of different rapid transit modes, evaluating rapid transit, Problems.		
Unit III	**Planning**	**(8 Hrs)**
Planning: Transportation system management, system and service planning, financing public transportation, management of public transportation, public transportation marketing.		
Unit IV	**Transit System Evaluation**	**(7 Hrs)**
Transit System Evaluation: Definition of quantitative performance attributes, transit lane capacity, way capacity, station capacity, theoretical and practical capacities of major transit modes, quantification of performance, Problems.		
Unit V	**Urban Traffic**	**(8 Hrs)**
Urban traffic: Classification of transportation systems, conventional transportation systems, non-conventional transportation systems, prototypes and tomorrow's solutions, analysis and interpretation of information on transportation systems, perspectives of future transportation.		
Unit VI	**Urban Goods Movement**	**(7 Hrs)**
Introduction; Classification of urban goods movement; Factors affecting goods movement; Modelling Approaches, Emerging Trends in Transportation planning Activity based modelling.		

Learning Resources

Textbooks:

1. P. R. Rethaliya *"Urban Transportation Planning"* Atul Prakashan
2. George E. Gray and Lester A. Hoel, *"Public Transportation"* Prentice Hall, New Jersey.
3. Vukan R. Vulchic, *"Urban Public Transportation System and Technology"*, Prentice Hall, New Jersey.

Reference Books:

1. Kadiyali L.R., *"Traffic Engineering and Transport Planning"*, Khanna Publishers. 1999
2. S.C. Saxena, *"Traffic Planning and Design"*, Dhanpat Rai Pub., New Delhi. 1989
3. Ortuzar J.D. and Willumsen L.G., Modelling Transport, John Wiley & Sons, Ltd.,2011
4. Meyer M.D. and Miller E.J., *"Urban Transportation Planning: A Decision-oriented Approach"*, Mc Graw Hill, New York, 2001.
5. HorstR. Weigelt, Rainer E. Gotz, HelmutH. Weiss,' *"City Traffic-A Systems Digest"* ,Van Nostrand Reinhold Company , New York

MOOC / NPTEL Courses for basic knowledge:

1. NPTEL Course "*Urban Transportation Systems Planning*", Prof. Bhargab Maitra, IIT Kharagpur

Link of the Course:
https://archive.nptel.ac.in/courses/105/105/105105208/

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester III

Course Type: PEC	**Course Title:** Highway Planning and Economic Development	
Course Code: 230GTEM09_03	**Teaching Scheme:**	**Examination Scheme:**
Credits: 3.0	**Lecture (L): 03** **Tutorial (T): --** **Practical (P): --** **Experiential Learning (EL): 00**	**CIE: 100 Marks** **ESE: 100 Marks**

Prerequisite Courses, if any:

Course Objective:

- To introduce students to various ongoing and proposed highway development initiatives in India.
- To understand the framework of road project planning and the principles of effective project management.
- To study the economic theories and models applicable to transportation demand and supply, and evaluate user behavior and cost dynamics.
- To familiarize students with cost components related to road usage and methods used for economic assessment in road projects.
- To enable students to perform comprehensive economic analysis and evaluate various road project alternatives using established financial indicators.
- To study the financing mechanisms and investment decision tools used in highway project development.

Course Outcomes: On completion of the course, learner will be able to

CO1: Identify and evaluate the scope, type, and planning considerations for different highway development projects in India.

CO2: Analyze the key components and lifecycle of road project planning and apply project management techniques to mitigate risks and failures.

CO3: Apply economic principles and demand models to assess the effectiveness of highway pricing, subsidy policies, and user behavior.

CO4: Quantify and interpret road user costs and identify benefits from highway improvement using Indian case studies.

CO5: Carry out economic evaluations and prioritize road projects based on different improvement options and cost-benefit metrics.

CO6: Evaluate various highway financing options and utilize decision-making tools for planning and investment.

Course Contents

Unit I	**Highway Development and Planning in India**	**(8 Hrs)**

Types of highway development projects in India, Scope and current status, Factors to be considered in planning new highways, expressways, bypasses, Up-gradation of existing roads.		
Unit II	**Road Project Planning and Management**	**(7 Hrs)**
Planning of Road Projects, Project management framework, Scope and objectives of projects, Project environment, Causes of project failure, Project development process.		
Unit III	**Principles of Highway Engineering Economics**	**(8 Hrs)**
Economic principles: Supply and demand models, Equilibrium in travel demand, Sensitivity of travel demand, Elasticity – types, Kraft demand model, Consumer surplus cost, Cost elasticity, pricing and subsidy policies.		
Unit IV	**Road User Costs and Transportation Economics**	**(7 Hrs)**
Vehicle Operating Cost (VOC), Direct and indirect benefits of road improvement, Total transportation cost, Fixed and variable costs, Road user cost studies in India		
Unit V	**Road User Costs and Transportation Economics**	**(8 Hrs)**
Economic analysis methods, Annual cost, Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR), Financial IRR (FIRR), Net Present Value (NPV), Sensitivity analysis, Economic analysis of road improvements, bypasses, intersection upgrades, Project prioritization and handling uncertainties.		
Unit VI	**Highway Financing and Investment Decisions**	**(7 Hrs)**
Highway and bridge project financing, Cess, tolling, BOT, BOOT models, Economic and financial analysis, Investment decision packages, Use of computer software tools.		

Learning Resources

Textbooks:

1. L.R. Kadiyali “Traffic Engineering and Transport Planning”-Khanna Publishers, New Delhi.
2. Winfrey, “Economic analysis for Highways”, International Textbook Company,Pennslyvania,1969

Reference Books:

1. Prasanna Chandra “Financial Management”-Tata McGraw, NewDelhi.
2. Woods K.B, Berry, D.S. and Goetz W.H, “Highway Engineering”-McGraw Hill BookCo.
3. Ian G. Heggie, “Transportation Engineering Economics”-McGraw Hill BookCo.
4. “Road User Cost Study in India”- Final Report, Central Road Research Institute, New Delhi,1982.
5. Ministry of Road Transport and Highways, “Road Development Plan for India”- 2001-2021, Indian Roads Congress, New Delhi,2002.
6. IRC “A Manual for the Application of Critical Path Method to Highway Projects inIndia”
9. Nhai.org, pmgsy.nic.inwebsites

MOOC / NPTEL Courses for basic knowledge:

2. NPTEL Course “*Transportation Engineering I* ”, Dr. Tom V Mathew, IIT Bombay
Link of the Course:https://nptel.ac.in/courses/105/101/105101087/

JSPM University Pune S.Y. M. Tech "Transportation Engineering" Semester III		
Course Type: PEC II	**Course Title:** Road Safety and Road Safety Audit	
Course Code: 230GTEM10_03	**Teaching Scheme:** **(Hrs./Week) 3**	**Examination Scheme:**
Credits: 3	**Lecture (L): 03** **Tutorial (T):** **Practical (P):** **Experiential Learning (EL):**	**Theory (TH): 100 Marks**

Prerequisite Courses, if any:
1. Traffic Engineering

Course Objective:

- To gain an understanding of the foundational principles and theories underlying road safety and road safety auditing.
- To acquire the knowledge and skills necessary to assess and recommend relevant road safety standards.
- To develop proficiency in conducting thorough and efficient road safety audits.
- To learn how to perform detailed road safety inspections, and synthesizing findings into comprehensive reports.
- To understand the different stages involved in the road safety audit process.
- To develop the techniques and methodologies essential for conducting construction stage road safety audits.

Course Outcomes: On completion of the course, learner will be able to
CO1: Understand fundamental concepts of road safety and road safety auditing.
CO2: Recommend appropriate road safety standards to different transit stakeholders.
CO3: Execute road safety audits effectively.
CO4: Conduct road safety inspections and generate comprehensive reports.
CO5: Determine the suitable stages for conducting road safety audits.
CO6: Perform construction stage road safety audits proficiently.

Course Contents

Unit I	Introduction to Road Safety	(7 Hours)

Introduction & need for Road Safety, Global & National Road Safety scenario, Road crash investigation report, Identifying Road crash Characteristics, Human Factors Relating to Crashes/Accidents, Crash/Accident Investigation, Introduction to Implementation of forgiving systems approach, Road Safety Initiatives by iRAP, World Bank & Other development authorities/ NGOs.

Unit II	Urban Road Safety and Infrastructure	(8 Hours)

IRC standards for road safety, Urban roads safety, pedestrian safety-oriented design, Trauma Care, Importance of golden hour within a road crash, Traffic Signal timing optimization & design with pedestrian signals, Provisions for NMT infrastructure, Safety Provisions for Pedestrians & Cyclists, Nighttime illumination. Safe System Approach- A Global Perspective, Speed Management & safety.		
Unit III	**Road Safety Auditing**	**(8 Hours)**
Road Safety Auditing: An Introduction, Concept and need of Road Safety Audit (RSA). Procedures in RSA, design standards, audit tasks, stages of road safety audit, Road Safety Audit Types, key legal aspects, process, audit team and requirements, Checklist, how to use Checklists.		
Unit IV	**Road Safety Inspection and Report**	**(7 Hours)**
Road Safety inspection. Road design issues in RSA's. Overview of Road Safety Hazards. Report writing including deficiency identification, corrective actions recommendations. Structuring RSA report. Hazard Identification and Management, Risk Assessment & Prioritization of audit recommendations.		
Unit V	**Planning and Design Stage**	**(8 Hours)**
Performing planning & design stage road safety audit, pre-opening & existing stage of safety audit, assessing factors responsible for deciding/ relocating the road alignment, before/ after analysis as a case study.		
Unit VI	**Construction Stage Road Safety Audits**	**(7 Hours)**
Introduction to Construction Stage Road Safety Audits, Performing Construction Stage Safety Audits on Urban Roads, Safety at Construction Site: Safety provisions for workers at construction site, Construction Zone markings, standard barricading, and work zone signage & marking plan.		

Learning Resources

Textbooks:

1. Martin Belcher, Steve Proctor, Phil Cook *"Practical Road Safety AUditing"* ICE Publishing - 2015
2. K.W. Ogden, `Safer Roads – A Guide to Road Safety Engg.' Averbury Technical, Ashgate Publishing Ltd., Aldershot, England, 1996.

Reference Books:

1. Highway Safety Manual by Transportation Research Board
2. Kadiyali, L.R., `Traffic Engineering and Transport Planning', Khanna Publications
3. Babkov, V.F. `Road conditions and Traffic Safety', MIR publications, - 1975.
4. Khanna and Justo , 'Highway Engineering', Nem Chand & Brothers, Roorkee.
5. Pignataro, Louis, `Traffic Engineering - Theory and Practice', John Wiley.
6. RRL, DSIR, `Research on Road Safety', HMSO, London
7. IRC SP 88- 2019 Road Safety Audit Manual (Second Revision)
8. IRC SP 55 2015 Work Zone Traffic Management

MOOC / NPTEL Courses for basic knowledge:

1. NPTEL Course "*Traffic Engineering*", Prof. Bhargab Maitra, IIT Kharagpur

Link of the Course:

https://nptel.ac.in/courses/105105215

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester III

Course Type: PEC II	**Course Title:** Airport, Railway, Docks, and Harbor Engineering	
Course Code: 230GTEM11_03	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 3	**Lecture (L):** 3 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 100 marks

Prerequisite Courses, if any:

Course Objectives:

- To impart knowledge on the planning, design, and operation of airports, railways, docks, and harbours.
- To develop an understanding of the functional elements and layout considerations for various transportation infrastructures.
- To familiarize students with modern construction and maintenance practices for sustainable transport systems.
- To promote integrated transport planning and coordination across different modes like air, rail, and water.

Course Outcomes: On completion of the course, learner will be able to

CO1: Explain the characteristics and classification of air transport and design principles of airports.

CO2: Apply runway and taxiway design concepts using ICAO guidelines.

CO3: Understand railway track components, construction methods, and maintenance procedures.

CO4: Design railway geometry considering various parameters and develop suitable alignments.

CO5: Describe the types, construction, and maintenance of docks and their integration with ports.

CO6: Analyze harbour planning principles, terminal facilities, and coastal protection methods.

Course Contents

Unit I	**Airport Planning**	**(7 Hours)**

Air transport characteristics, airport classification, air port planning: objectives, components, layout characteristics, and socio-economic characteristics of the catchment area, criteria for airport site selection and ICAO stipulations, typical airport layouts, Parking and circulation area.

Unit II	Airport Design	(8 Hours)
Runway Design: Orientation, Wind Rose Diagram, Runway length, Problems on basic and Actual Length, Geometric design of runways, Configuration and Pavement Design Principles, Elements of Taxiway Design, Airport Zones, Passenger Facilities and Services, Runway and Taxiway Markings and lighting.		
Unit III	**Railway Planning**	**(8 Hours)**
Significance of Road, Rail, Air and Water transports – Coordination of all modes to achieve sustainability – Elements of permanent way – Rails, Sleepers, Ballast, rail fixtures and fastenings, – Track Stress, coning of wheels, creep in rails, defects in rails – Route alignment surveys, conventional and modern methods- – Soil suitability analysis – Geometric design of railways, gradient, super elevation, widening of gauge on curves- Points and Crossings.		
Unit IV	**Railway Construction and Maintenance**	**(7 Hours)**
Earthwork – Stabilization of track on poor soil, Calculation of Materials required for track laying – Construction and maintenance of tracks – Modern methods of construct ion & maintenance – Railway stations and yards and passenger amenities- Urban rail – Infrastructure for Metro, Mono and underground railways.		
Unit V	**Docks**	**(7 Hours)**
Definition, types and functions of docks, including wet docks, dry docks, and floating docks. It focuses on their design, construction, layout planning, and essential accessories. Maintenance practices and case studies are also discussed to provide practical insight.		
Unit VI	**Harbour**	**(8 Hours)**
Definition of Basic Terms: Planning and Design of Harbours: Requirements, Classification, Location and Design Principles – Harbour Layout and Terminal Facilities , Coastal Structures, Inland Water Transport – Wave action on Coastal Structures and Coastal Protection Works.		

Learning Resources

Text Books:

1. Satish Chandra and Agarwal M. M,“Railway Engineering”, 2nd Edition, Oxford University Press,New Delhi.
2. Khanna S K, Arora M G and Jain S S,“Airport Planning and Design”, Nemch and and Brothers, Roorkee.
3. C Venkatramaiah, “Transportation Engineering”, VolumeII: Railways, Airports, Docks and Harbours, Bridge sand Tunnels, Universities Press.

Reference Books:

1. Oza.H.P.andOza.G.H.,“AcourseinDocks&HarbourEngineering”.Charotar Publishing Co.,
2. Mundrey J. S. “A course in Railway Track Engineering”.Tata Mc Graw Hill.
3. Srinivasan R. Harbour,“ Dock and TunnelEngineering”,26thEdition2013.

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester III

Course Type: PEC II	**Course Title:** Intelligent Transport Systems	
Course Code: 230GTEM12_03	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 3	**Lecture (L):** 3 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 100 marks

Prerequisite Courses, if any:

Course Objectives:

- To introduce the fundamentals, objectives, and benefits of Intelligent Transportation Systems (ITS).
- To explore the role of telecommunications, data collection, and traffic management in ITS.
- To analyze the functional areas of ITS, including traffic management, vehicle control, and public transport systems.
- To understand user needs and services such as electronic payment, emergency response, and safety systems.
- To examine automated highway systems and global ITS implementations in both developed and developing nations.
- To assess the environmental impact of ITS and explore sustainable solutions for smart mobility and green transportation.

Course Outcomes: On completion of the course, learner will be able to

CO1: Explain the objectives, benefits, and data collection techniques of ITS.
CO2: Understand communication technologies and Traffic Management Centers.
CO3: Analyze various ITS applications like ATMS, ATIS, and AVCS for efficient transport.
CO4: Evaluate ITS solutions for traffic management, public transport, and safety.
CO5: Examine AHS, vehicle platooning, and global ITS implementations.
CO6: Assess eco-friendly ITS solutions, emission monitoring, and climate resilience.

Course Contents

Unit I	**Introduction to Intelligent Transportation Systems (ITS)**	**(8 Hours)**

Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

Unit II	**Telecommunications in ITS**	**(7 Hours)**

Importance of telecommunications in the ITS system, Information Management, Traffic

Management Centres (TMC). Vehicle – Roadside communication – Vehicle Positioning System		
Unit III	**ITS functional areas**	**(8 Hours)**
Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).		
Unit IV	**ITS User Needs and Services**	**(7 Hours)**
Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.		
Unit V	**Automated Highway Systems**	**(8 Hours)**
Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.		
Unit VI	**Sustainability and Environmental Impact of ITS**	**(7 Hours)**
Introduction to Sustainable ITS. Eco-Traffic Management, Electrification and ITS. ITS for Non-Motorized Transport, Air Quality and Emission Monitoring. ITS in Climate Resilience and Disaster Management. Case Studies on Green ITS Initiatives.		

Learning Resources

Text Books:

1. Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola "Intelligent Transport Systems: Smart and Green Infrastructure Design" (2015)
2. Asad J. Khattak & Ali Shariat-Mohaymany "Intelligent Transport Systems: Technologies and Applications"

Reference Books:

1. Pradip Kumar Sarkar and Amit Kumar Jain; Intelligent Transportation Systems' PHI Learning, 2018
2. Mashrur Chowdhury and Adel W. Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House Publishers, 2003
3. Relevant IRC codes, publisher IRC

JSPM University Pune S.Y. M. Tech. "Transportation Engineering" Semester- III		
Course Type: IOC	**Course Title:** Fundamentals of Artificial Intelligence and Machine Learning	
Course Code: 250GCSM03_03	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits:	**Lecture (L):** 2 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 100 Marks

Prerequisite Courses, if any: Algorithms. Probability Theory; Statistics; Computer Science.

Course Objectives:

- To learn basics of Artificial Intelligence including core features.
- To study different types of AIML and its Application.
- To understand the importance of AI for Industries.
- To use AI and ML various domains of Civil Engineering.

Course Outcomes: On completion of the course, the learner will be able to:
CO1: Understand the basics of AI and ML application for Industries.
CO2: Apply various Tools & Technology for AIML.
CO3: Implement the AIML for real-world problems.
CO4: Analysis the functionality of AIML.
CO5: Evaluate the performance of Tools & Technology applied in Industries.

Course Contents

Unit I	**Introduction to AIML**	**(5 Hours)**

Scope of the Course, Introduction to AI and ML, Brief review of History of AI and ML, Related fields. Concept of AI, Types of AI, Characteristics of AI, Key aspects of AI, Important of AIML, Application of AI.

Unit II	**Regression Analysis**	**(5 Hours)**

Overview of Machine Learning, Linear regression, Types of linear regression, Application of linear regression, Real-world use cases of linear regression, Logistics Regression, Models with multiple features, Correlation and Classification.

Unit III	**Application of ML**	**(5 Hours)**

Introduction to Clustering, Types of Clustering, Segmentation, Anomaly detection, and pattern recognition. Clustering Algorithms in Machine Learning: K-Mean, Applications of Clustering, Advantages Clustering.

Unit IV	**Bayesian Application**	**(5 Hours)**

An overview of Bayesian Networks in AI, Application of Bayesian networks in AI, Bayesian Network Model, Probabilistic Graphical Model. Decision Graph, Risk Model with Bayesian Network, Dynamic Bayesian Model.		
Unit V	**Infrastructure Monitoring and Management**	**(5 Hours)**
Introduction to infrastructure monitoring, Data integration with AIML, Ethical considerations in AI and ML Applications, Regulatory challenges and standards in civil engineering,		
Unit VI	**Case Study/Project**	**(5 Hours)**
Structural Analysis and Design, Construction Management, Geotechnical Engineering, Transportation Engineering, Environmental Engineering, Smart Cities and Sustainable Development, Building Information Modeling, Responsible AI development and deployment.		

Learning Resources

Text Books:

1. AI and Machine Learning with Python for Everyone, Mark Fenner, Pearson
2. Machine Learning, Anuradha Srinivasaraghavan, Vincy Joseph, Wiley
3. Machine Learning with Python, U Dinesh Kumar Manaranjan Pradhan, Wiley

Reference Books:

1. Neural Networks, Fuzzy Logic, and Genetic Algorithms : Synthesis and Applications By S. Rajshekharan, G. A. Vijayalakshmi Pai, PHI
2. KishanMehrotra, Chilukuri Mohan and Sanjay Ranka, Elements of Artificial Neural Networks, Penram International
3. Tom Mitchell, Machine Learning, TMH
4. AthemEalpaydin, Introduction to Machine Learning, PHI 8. Andries P. Engelbrecht, Computational Intelligence - An Introduction, Wiley Publication

MOOC / NPTEL Course:

1. NPTEL Course titled “AIML Applications” IIT Madars, by Prof. C.A. Murthy and Prof. Sukhendu Das.

Link:1. https://www.geeksforgeeks.org/machine-learning/
2. https://www.tutorialspoint.com/machine_learning_with_python/index.htm

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester III

Course Type: IOC - I	**Course Title:** Fundamentals of Financial Management	
Course Code: 230VMSM11_03	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 2	**Lecture (L):** 2 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 100 Marks

Prerequisite Courses, if any:
- Basics of Accounting
- Principles of Economics
- Business Mathematics

Course Objectives:
1. To provide an understanding of the core concepts of financial management and its importance in business decisions.
2. To equip students with the skills to analyze financial statements and understand the financial health of a business.
3. To develop the ability to make informed financial decisions and manage financial risks.
4. To introduce recent trends and industry practices in financial management.

Course Outcomes:
CO1: Explain the fundamental concepts of financial management (PO1, PO2).
CO2: Analyze financial statements to assess the financial performance of an organization (PO2, PO3).
CO3: Apply financial management techniques to make investment and financing decisions (PO4, PO5).
CO4: Evaluate financial risks and devise strategies to mitigate them (PO6, PO7).
CO5: Integrate knowledge of recent trends and industry practices in financial decision-making (PO8, PO9).
CO6: Demonstrate the ability to communicate financial information effectively (PO10).

Course Contents

Unit I	**Introduction to Financial Management**	**(5 Hours)**
Definition, nature, and scope of financial management; Goals of financial management; Recent trends in financial management. Basic financial calculations (e.g., profit margin, return on investment)		
Unit II	**Financial Analysis and Planning**	**(5 Hours)**
Financial statement analysis; Ratio analysis; Cash flow and fund flow analysis. Calculation of financial ratios and interpretation (e.g., liquidity ratios, profitability ratios).		
Unit III	**Time Value of Money**	**(5 Hours)**

Concept of the time value of money; Present value and future value calculations; Applications in financial decision-making. Present value and future value problems, annuity calculations, discounting cash flows.		
Unit IV	**Investment Decisions**	**(5 Hours)**
Capital budgeting techniques; Risk analysis in capital budgeting; Recent trends in investment decisions. Net present value (NPV), Profitability Index, IRR, payback period calculations.		
Unit V	**Financing Decisions**	**(5 Hours)**
Cost of capital; Capital structure theories and planning; Sources of long-term finance. Calculating the cost of equity, debt, and weighted average cost of capital (WACC).		
Unit VI	**Working Capital Management**	**(5 Hours)**
Concepts and components of working capital; Management of cash, receivables, and inventory; Financing of working capital. Working capital cycle, inventory turnover ratio, receivables turnover ratio.		
Learning Resources		
Text Books: 1. I.M. Pandey "*Financial Management*" 2. Richard A. Brealey, Stewart C. Myers, and Franklin Allen "*Principles of Corporate Finance*" **Reference Books:** 1. Aswath Damodaran "*Corporate Finance*: *Theory and Practice*" 2. Eugene F. Brigham and Michael C. Ehrhardt "*Financial Management: Theory & Practice*" 3. David Hillier, Mark Grinblatt, and Sheridan Titman "*Financial Markets and Corporate Strategy*" 4. R. Charles Moyer, James R. McGuigan, and Ramesh P. Rao "*Contemporary Financial Management*"		
MOOC / NPTEL Course: Coursera Course on Financial Management		

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester III

Course Type: IOC	**Course Title:** Basics of Accounting	
Course Code: 230VBCB04_03	**Teaching Scheme: (Hrs./ Week)**	**Examination Scheme:**
Credits: 2	**Lecture (L): 2** **Tutorial (T): 0** **Practical (P): 0** **Experiential Learning (EL): 0**	**Theory (TH): 100 Marks**

Prerequisite Courses, if any:

Course Objectives:

1. To foster a comprehensive understanding of the role and significance of monetary and financial transactions in business operations.
2. To develop an appropriate approach towards the classification of various transactions and their implications.
3. To develop proficiency in preparing basic financial statements, including Trading and Profit & Loss Accounts and Balance Sheets.
4. To understand the nature of the accounting relationship between customers and banks.

Course Outcomes: On completion of the course, the learner will be able to -

CO1: Remember fundamental accounting concepts and principles.
CO2: Understand the role and importance of monetary and financial transactions in business.
CO3: Apply appropriate classification to various financial transactions.
CO4: Analyze basic financial statements, including Trading and Profit & Loss Accounts and Balance Sheets.
CO5: Prepare basic financial statements from given financial data.
CO6: Rectifying errors in solved accounting problems with proper solutions if required.

Course Contents

Unit I	**Introduction to Basic Accounting & Bookkeeping**	**5 Hrs**
Basic Terminology in Accounting and Bookkeeping, Accounting Concepts, Accounting Conventions, GAAP, Types of Accounts and Rules, Types of Transactions		
Unit II	**Books of Accounting**	**5 Hrs**
Journal, Ledger, Subsidiary Books, Problems of Journal, Problems of Ledger, Problems of Trial Balance		
Unit III	**Cash Book and Subsidiary Books**	**5 Hrs**
Cash Book – Meaning and Definition, Cash Book – Need and Importance, Types of Cash Book, Subsidiary Book and its types		
Unit IV	**Preparation of Final Accounts**	**5 Hrs**

Types of Business, Need for Financial Statements, Formats of Financial Statements, Trading Account, Profit & Loss Account, Balance sheet, Problems of Final Accounts of Sole Trading Organizations		
Unit V	**Depreciation & Provision for Bad and Doubtful Debts**	**5 Hrs**
Meaning and Concept of Depreciation, Reasons for Depreciation, Methods of Depreciation		
Unit VI	**Bank Reconciliation Statement**	**5 Hrs**
Meaning of BRS, Need for BRS, Importance of BRS, Process of BRS, Formats of BRS, Preparation of BRS and Problems of BRS		

Learning Resources
Text Books: 1) P. Periasamy *'Financial, Cost, and Management Accounting'*, Himalaya Publishing Ltd. 2) Dr. Mahesh Abale and Dr. Shriprakash Soni, *'Managerial Accounting'*, Himalaya Publishing Ltd.
Reference Books: 1) Khan and Jain, *'Management Accounting'*, Tata McGraw Hill 2) Shankarnarayanan Ramanath, 'Financial Accounting for Management', CENGAGE Learning 3) S.N. Maheshwari & S.K. Maheshwari, 'Advance Accounting', Vikas Publication 4) M.C. Shukla, T.C. Grewal, S.C. Gupta, 'Advance Accounting', Sultan Chand and Sons 5) R.L. Gupta, M. Radhaswamy, 'Advance Accounting', Sultan Chand and Sons
MOOC / NPTEL Courses: 1) Swayam Course *"BCOC-131- Financial Accounting"*, Dr. N. Rajendra Prasad, Indira Gandhi National Open UniversityBCOC-131- Financial Accounting **Link of the Course:** 1) https://onlinecourses.swayam2.ac.in/nou23_cm13/preview **Additional Web Resources:** 1) https://icmai.in/ 2) https://www.icai.org/ 3) https://www.icsi.edu 4) https://www.cimaglobal.com/

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester III

Course Type: VEC	**Course Title:** Behavioral Science and Ethics	
Course Code: 230USYB01_01	**Teaching Scheme:** **(Hrs./Week)**	**Examination Scheme:**
Credits: 2	**Lecture (L):** 2 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 50 Marks

Prerequisite Courses, if any:

1. NIL

Course Objectives:

- To prepare students for their future endeavors by imparting a sense of self, understanding their surroundings and their nation.
- The course also teaches strategies to lead healthy lifestyles with a positive attitude.
- It enables students to learn the process of problem solving and creative thinking.
- In the second part of the course, the students are being prepared for their professional development by inculcating leadership skills and ethical work values.

Course Outcomes: On completion of the course, learner will be able to

CO1: Understanding sense of self, nation, and society they are living in.
CO2: Applying strategies to manage stress and understanding stress and its consequences.
CO3: Analyzing problem and Strategizing way to solve it.
CO4: Evaluating group dynamics and leadership skills.
CO5: Creating healthy and ethical workspace.
CO6: Remembering values, morality, and ethics through thick and thin of life.

Course Contents

Unit I	Self	(5 Hrs)

I. What is Behavioural science and its significance
II. Self-awareness and its importance
III. Components of self and self-identity
IV. Self-concept
V. Self confidence
VI. Self-image

Unit II	Stress Management	(5 Hrs)

I. What is stress? and understanding reasons for stress.
II. What are possible consequences of the stress?
III. How to accept stress and share your emotions.
IV. What are strategies to manage stress?
V. Why seeking help is important when needed?

Unit III	Thinking, Perceiving and Problem Solving	(5 Hrs)

I. How to approach and analyze a problem?
II. How to think?
III. How to strategize and plan actions?
IV. How to implement plans of action?
V. What is creative thinking and how to process it?

Unit IV	Group Dynamics and Leadership Skills	(5 Hrs)

I. Definition and characteristics of group
II. What are external and internal conditions affecting group functioning?
III. What are group conflict and group cohesiveness?
IV. Meaning, nature and functions of leadership
V. What are characteristics of a good leader?

Unit V	Indian Ethics	(5 Hrs)

I. Sources of Moral Ideals in India, Ethics: Its Meaning in Indian Tradition
II. Ethics in Vedic Period, Ethics in Dharmasastras and Itihasas
III. Way of Righteousness in the Gita, Ethical Concepts of Hindu Tradition
IV. Ethics in Buddhism, Jaina Ethics

Unit VI	Western Ethics	(5 Hrs)

I. Aristotle, Thomas Aquinas
II. William of Ockham, Thomas Hobbes
III. Jeremy Bentham, Immanuel Kant
IV. John Stuart Mill
V. Emile Durkheim

Learning Resources

Textbook:

1. Bates. A. P and Jullian J “Sociology: Understanding social Behaviour”, Houghton Mifflin, 1975.

Reference Book:

1. J William Pfeiffer (ed) Theories and Models in Applied Behavioural Science, Vol 2, Group (1996); Pfeiffer and company.
2. William Frankena K, Ethics, Prentice-Hall, Inc., 1973
   https://dorshon.com/wp-content/uploads/2018/03/Ethics.pdf

MOOC / NPTEL Course:

1. NPTEL Course: “https://onlinecourses.nptel.ac.in/noc20_hs28/preview”, Prof. Naveen Kashyap, IIT Guwahati

Other online material

Ethics notes IGNOU - https://egyankosh.ac.in/handle/123456789/4774

JSPM UNIVERSITY PUNE

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State Government of Maharashtra - JSPM University Act, 2022 (Mah.IV of 2023)

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester III

Course Type: SLC	**Lab Course Title:** Seminar	
Course Code: 240GTEM03_03	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 2	**Lecture (L):** **Tutorial (T):** **Practical (P):** **Experiential Learning (EL): 8**	**Oral (OR):** 50 Marks

Prerequisite Courses, if any: -

Objectives:

- To develop skills in literature survey, technical writing, and oral presentation.
- To enhance communication, organization, and time management skills in a professional setting.
- To encourage critical thinking, knowledge synthesis, and presentation on contemporary issues in Construction Management.
- To build confidence in presenting technical concepts and real-life project experiences to a professional audience.
- To create an opportunity to analyze and reflect on field training or internship outcomes.

Course Outcomes: On completion of the course, learner will be able to

CO1: Conduct a structured literature survey on a relevant topic or project.
CO2: Identify, define, and frame a technical problem or theme for presentation.
CO3: Prepare a comprehensive seminar report following academic standards.
CO4: Deliver an effective oral presentation with confidence and clarity.
CO5: Demonstrate analytical thinking and communication skills.
CO6: Incorporate feedback from faculty and peers to improve their work.

Seminar Guidelines:

- Each student will select a topic related to their internship/field project, or a current trend/challenge/innovation in Construction Management.
- Topics must be approved by the Seminar Coordinator.
- Students are expected to consult journal papers, industry reports, codes, standards, and project documentation.
- A seminar report (hard and soft copy) must be submitted in the prescribed format.

Seminar Report Format (Recommended):

1. Title Page
2. Certificate from Guide
3. Acknowledgement
4. Abstract (max 300 words)
5. Table of Contents
6. Introduction
7. Objectives of the Study
8. Literature Review / Background
9. Problem Statement / Case Study Description
10. Methodology / Techniques Used / Field Observations
11. Analysis, Results, and Discussion
12. Conclusions and Recommendations
13. References (APA / IEEE style)
14. Appendices (if any)

Seminar Evaluation Criteria

1. **Seminar Report**
   - Structure and formatting (Title page, index, references, etc.)
   - Clarity of objectives and problem statement
   - Quality and depth of literature review or background study
   - Methodology or approach followed
   - Analysis, observations, or findings from case studies
   - Conclusions, recommendations, and originality/innovation
2. **Oral Presentation**
   - Communication and presentation skills
   - Depth of subject knowledge
   - Use of visual aids (PowerPoint/other media)
   - Handling of questions and audience interaction
   - Confidence, fluency, and professionalism
   - Effective time management
3. **Overall Contribution and Conduct**
   - Regularity and punctuality in meetings and submissions
   - Active participation and coordination with the guide
   - Maintenance of logbook/diary
   - Feedback from seminar guide or external/internal supervisor

Instructions for Students:

- Submit the proposed seminar topic in Week 1 of the semester.
- Attend all review meetings with your assigned guide.
- Weekly progress must be recorded and presented to the guide.
- Final seminar presentations to be conducted in Weeks 14–16 before a departmental panel.
- No plagiarism; originality will be checked and penalized if found otherwise.

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester III

Course Type: IITP/FP/CEP	**Lab Course Title:** Field Project	
Course Code: 240GTEM01_03	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 4	**Lecture (L):** **Tutorial (T):** **Practical (P):** 4 **Experiential Learning (EL): 8**	**Oral (OR):** 100 Marks

Prerequisite Courses, if any: -

Objectives:

- To identify, investigate and work on real-world industry problems.
- To develop skills in problem formulation, literature survey, methodology design, data collection, and analysis.
- To encourage independent thinking, research aptitude, and professional project documentation.
- To apply academic learning to practical engineering and management challenges.

Course Outcomes: On completion of the course, learner will be able to

CO1: Identify and define a researchable or practical problem in construction management.
CO2: Conduct an in-depth literature survey related to the topic.
CO3: Design a suitable methodology for field/project investigation.
CO4: Initiate data collection, modeling, or analysis.
CO5: Present findings and future scope effectively through a structured report and seminar.
CO6: Demonstrate time management, documentation, and communication skills.

Field Project Scope:

- Selection of problem/topic (based on industrial challenge, societal need, or academic relevance).
- Review of literature, background study, and framing of research/problem statement.
- Defining objectives, scope, and methodology.
- Preliminary data collection or case studies (if applicable).
- Submission of Project Proposal Report and Mid-Term Review Presentation.

Evaluation Criteria (Semester III - 100 Marks):

1. Problem Identification and Relevance
2. Literature Survey and Technical Understanding
3. Project Planning, Scope, and Methodology
4. Preliminary Work / Case Study / Field Work Progress
5. Regularity, Discipline, and Interaction with Guide
6. Mid-Semester and Final Presentation Skills
7. Documentation and Project Report

Instructions for Students (Phase I):

1. Topic Selection
   - Select a relevant, practical, or innovative topic in consultation with your assigned guide.
   - The topic may be industrial, societal, research-based, or field-oriented.
2. Proposal Preparation
   - Submit a project proposal including: problem statement, objectives, scope, review of literature, and proposed methodology.
3. Weekly Progress
   - Maintain regular contact with your internal guide (at least once a week).
   - Submit progress updates in your project logbook.
4. Mid-Semester Review
   - Present your progress in a departmental review to receive constructive feedback.
5. Interim Report Submission
   - Prepare a structured report containing proposal details, literature survey, initial work, methodology, and proposed data sources.
6. Plagiarism
   - Ensure your work is original and properly referenced. Plagiarism will result in rejection of report.
7. Final Presentation
   - Present your Phase I work before an evaluation panel and receive approval to proceed to Phase II.

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester IV

Course Type: PEC	**Course Title:** Safety in Highways and Airports	
Course Code: 230GTEM13_04	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 3	**Lecture (L):** 3 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 100 marks

Prerequisite Courses, if any:

Course Objectives:

- To understand the fundamental principles of highway and airport safety.
- To analyze road safety engineering, accident prevention techniques, and traffic management strategies.
- To evaluate accident analysis methods and implement safety measures for vulnerable road users.
- To study airport safety management systems, including runway safety, fire response, and wildlife hazards.
- To explore air traffic control, aviation security threats, and emergency response protocols.
- To assess sustainable safety solutions, emerging technologies, and future trends in transportation safety.

Course Outcomes: On completion of the course, learner will be able to

CO1: Explain the key concepts, causes, and regulations related to highway and airport safety.
CO2: Apply design principles and traffic control measures to improve road safety.
CO3: Analyze accident data, assess risks, and recommend preventive measures.
CO4: Evaluate airport safety systems, including emergency response and runway safety.
CO5: Understand ATC operations, aviation security threats, and safety management.
CO6: Assess the impact of smart technologies and sustainability in transportation safety.

Course Contents

Unit I	**Introduction to Highway and Airport Safety**	**(7 Hours)**

Importance of safety in transportation infrastructure. Common causes of accidents on highways and at airports. Human, vehicle, and environmental factors affecting safety. Safety regulations and policies (IRC, AASHTO, ICAO guidelines).

Unit II	**Road Safety Engineering and Management**	**(8 Hours)**

Road design for safety: geometric design considerations, sight distance, super-elevation.

Traffic control devices: signs, signals, road markings, and barriers. Intelligent Transportation Systems (ITS) for road safety. Road Safety Audits (RSA) and crash investigation techniques.		
Unit III	**Highway Safety Measures and Accident Analysis**	**(8 Hours)**
Types of road accidents and statistical analysis of accident data. Crash prediction models and risk assessment techniques. Safety measures for vulnerable road users (pedestrians, cyclists). Speed management, enforcement strategies, and driver behavior analysis.		
Unit IV	**Airport Safety Management Systems**	**(7 Hours)**
Introduction to airport safety and safety management system. Runway and taxiway safety: preventing incursions and excursions. Aircraft rescue and firefighting (ARFF) procedures. Wildlife hazard management at airports.		
Unit V	**Air Traffic Safety and Security**	**(7 Hours)**
Air traffic control (ATC) and its role in aviation safety. Navigation aids and communication systems for safe air travel. Safety protocols for emergency landings and airport evacuations. Aviation security threats and countermeasures (terrorism, cyber threats).		
Unit VI	**Sustainable and Future Trends in Transportation Safety**	**(8 Hours)**
Sustainable safety solutions for highways and airports. Emerging technologies in safety: autonomous vehicles, AI, and big data. Role of climate resilience in transportation safety. Case studies on successful highway and airport safety implementations.		

Learning Resources

Text Books:

1. L.R. Kadiyali "Traffic Engineering and Transport Planning" 1999
2. C.E.G. Justo & S.K. Khanna "Highway Engineering" 2017
3. S.K. Khanna, M.G. Arora & S.S. Jain "Airport Planning and Design" 1999

Reference Books:

1. C.S. Papacostas & P.D. Prevedouros "Fundamentals of Transportation Engineering" – 2000
2. P. Tiwari & S. Bhandari "Road Safety Management" – 2009
3. John G. Wensveen "Air Transportation: A Management Perspective" – 2011

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester IV

Course Type: PEC III	**Course Title:** Advanced Concrete Technology and Application	
Course Code: 230GSEM15_04	**Teaching Scheme:**	**Examination Scheme:**
Credits: 3	**Lecture (L): 3** **Tutorial (T): -** **Practical (P): -** **Experiential Learning (EL): -**	**CIE: 100 Marks** **ESE: 100 Marks**

Prerequisite Courses, if any:

Course Objective:
To understand the various types of concrete and their ingredients
To know various Deterioration process of concrete
To understand the basic of additive manufacturing of concrete

Course Outcomes: At the end of course, Students will be able
CO1: To Demonstrate the standards, specifications, and properties of various concrete ingredients
CO2: To Identify and analyze the characteristics, applications, and benefits of advanced concrete
CO3: To Evaluate factors affecting the durability of concrete, including chemical attacks
CO4: To Investigate the use of waste materials and recycled aggregates in concrete production
CO5: To Assess the chemical durability and performance of specialized concrete types
CO6: To Analyze the challenges and methods involved in concreting under extreme conditions

Course Contents

Unit I	**Concrete Science**	**(6Hrs)**

Standards – specifications – Ingredients - cement and its types – Coarse Aggregate – Fine Aggregate.
Chemical admixtures - Mineral admixtures - Polymer concrete - Mix design - Mix Design by IS: 10262-2019 - Mix Design by ACI: 312

Unit II	**Concrete Types**	**(6Hrs)**

Normal Vibrated Concrete - High volume fly ash concrete - High strength concrete – Reactive powder concrete & Oil well concrete - Ready mix concrete, pervious concrete.
Fiber Reinforced Concrete – FRP in concrete - Self compacting concrete – Bacterial Concrete – Self curing concrete - Geopolymer Concrete.

Unit III	**Durability and fire hazards in concrete**	**(6Hrs)**

Deterioration of concrete - Factors effecting the durability - Sulphate attack - Acid attack Alkali Aggregate reaction – Carbonation – Abrasion - Freezing and Thawing - Corrosion of Rebar - Rapid Chloride penetration test

Unit IV	**Use of waste materials in concrete**	**(6Hrs)**

Waste from industry - Recycled aggregates – Sustainability Green concrete - Eco-Friendly Concrete		
Unit V	**Chemical Attack**	**(6Hrs)**
Chemical attack of concrete corrosion of steel rebars, other durability issues; Properties and applications of - High strength – high performance concrete, reactive powder concrete; Lightweight, heavyweight, and mass concrete		
Unit VI	**Special Concrete**	**(8Hrs)**
Tremie Method - Concrete in Cold weather - Concrete in Hot weather - miscellaneous topics, additive manufacturing of concrete (3D printing)		

Learning Resources

Textbooks:
1. Concrete Materials, Properties, Specification and Testing by S. Popovics, Standard Publishers, India
2. Properties of Concrete by A.M. Neville, ELBS Ed.

References:
1. Waste Materials in Concrete Manufacture by Satish Chandra, Indian Standard Publishers
2. Nondestructive Testing in Concrete by Bungey, Surrey University Press, London

MOOC / NPTEL Courses:
1. NPTEL https://nptel.ac.in/courses/105102012

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester IV

Course Type: PEC	**Course Title:** Ground Improvement Techniques	
Course Code: 230GTEM15_04	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 3	**Lecture (L):** 3 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):**	**Theory (TH):** 100 Marks

Prerequisite Courses, if any:
1. Soil Mechanics (Geotechnical Engineering I)
2. Foundation Engineering (Geotechnical Engineering II)

Course Objectives:
- To introduce various ground improvement techniques and their application to real-world scenarios.
- To equip students to analyze and apply compaction techniques for soil property enhancement.
- To develop skills to address ground improvement through hydraulic modifications.
- To provide understanding of admixture-based stabilization techniques for improving soils.
- To enhance skills in selecting and implementing grouting and in-situ soil treatment methods.
- To familiarize students with geosynthetics and their design applications in ground improvement.

Course Outcomes: Students completing the course will be able to:
CO1: Suggest suitable ground improvement techniques for various field conditions.
CO2: Analyze and apply compaction techniques, evaluating their effectiveness through modern control methods.
CO3: Recommend appropriate hydraulic modification systems to address geotechnical challenges.
CO4: Utilize various admixture-based stabilization techniques.
CO5: Select and implement advanced grouting methods and in-situ soil treatment techniques for complex ground conditions.
CO6: Analyze the functions and applications of various geosynthetics in improving soil behavior.

Course Contents

Unit I	**Introduction to Ground Improvement**	**(6 Hours)**

Introduction, Need for ground improvement, Different types of problematic soils, Ground improvement techniques for different soil types. Classification of ground improvement techniques, Factors affecting selection of ground improvement techniques, Benefits/objectives of ground improvement techniques.

Unit II	Mechanical Stabilization	(9 Hours)
Compaction, Shallow and deep compaction requirements, Field compaction, Compaction control: destructive and non-destructive methods, Properties of compacted soil, Types of specifications, Deep compaction, Dynamic compaction, Types of dynamic compaction, Ground vibrations, Vibro-compaction, Stone column.		
Unit III	**Hydraulic Modifications**	**(8 Hours)**
Ground improvement by drainage, Dewatering methods, Dewatering systems, Preloading, Vertical drains, Prefabricated vertical drains, Vacuum consolidation, Electro kinetic dewatering, Design and construction methods.		
Unit IV	**Modifications by Admixtures**	**(7 Hours)**
Cement stabilization and cement columns, Lime stabilization and lime columns, Stabilization using bitumen and emulsions, Stabilization using industrial wastes, Construction techniques and applications.		
Unit V	**Grouting and In-situ Soil Treatment Methods**	**(7 Hours)**
Grouting: Permeation grouting, Compaction grouting, Jet grouting, Different variety of grout materials, Grouting under difficult conditions. In-situ soil treatment Methods: Soil nailing, Rock anchoring, Micro piles.		
Unit VI	**Geosynthetics**	**(8 Hours)**
Geosynthetic materials: Geotextiles, Geogrids, Geonets, Geomembranes, Geosynthetic clay liners, Geo-pipe, Geofoam, Geocomposites. Functions of various geosynthetics: Filtration, Drainage, Separation, Protection, Impermeabilization, Reinforcement, Erosion control and surficial stabilization, Confinement, Design methods, Wall reinforcement design concepts, Geoenvironmental applications, Application areas of geosynthetics, Reinforced soil retaining walls. Application of geosynthetics in unpaved roads.		

Learning Resources

Text Books:

1. Mosely M. P., Kirsch K., Ground Improvement, CRC Press, 2nd edition, 2004.
2. Purushothama Raj, Ground Improvement Techniques, Laxmi Publications, 2nd edition, 2005.

Reference Books:

1. Manfired R., Hausmann, Engineering Principles of Ground Modification, McGraw Hill Book Co., New York, 1st edition, 1990.
2. M C. R. Davies, F. Schlosser, Ground Improvement Geosystems, CRC Press, 1st edition, 1997.
3. Koerner, R. M., Designing with Geosynthetics, Prentice Hall Inc., 4th edition, 2012.
4. Nayak, N. V., Foundation Engineering Manual, New age international publishers, 1st edition, 2009

MOOC / NPTEL Courses:

1. NPTEL Course "*Ground Improvement Techniques*", Prof. G. L. Shivkumar Babu, IISc Banglore

Link of the Course:

https://archive.nptel.ac.in/courses /105/108/105108075/

Additional Web Resources:

1. https://onlinecourses.nptel.ac.in/noc22_ce03/preview#

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester IV

Course Type:	**Course Title:** Sustainable Construction and Lean Construction	
Course Code: 230GTEM16_04	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 3	**Lecture (L):** 3 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 100 marks

Prerequisite Courses, if any:

Course Objectives:

- Understand sustainability concepts and their role in construction.
- Analyze environmental challenges, energy efficiency, and water conservation.
- Explore green building principles, eco-friendly materials, and recyclability.
- Apply lean principles to enhance construction productivity and efficiency.
- Examine project life cycles, lean project delivery, and collaborative planning.
- Implement lean design, supply chain integration, and modern project management tools.

Course Outcomes: On completion of the course, learner will be able to

CO1: Identify various concepts of sustainable construction
CO2: Apply sustainability to project planning
CO3: Choose appropriate sustainable materials and renewable energy techniques for civil engineering projects
CO4: Develop lean thinking and map lean culture in project delivery.
CO5: Interpret the Lean delivery systems.
CO6: Demonstrate skill in applying Lean planning tools.

Course Contents

Unit I	**Sustainability and Sustainable Development.**	**(7 Hours)**

Introduction to course. Introduction to sustainable development Concepts and Theory. Definitions and Prospective on sustainability, Theory and background to sustainable construction planning. The Three E's. Environment, Economics, and Ethics. Ecology of sustainable developments.

Unit II	**Sustainable Construction Planning.**	**(8 Hours)**

Introduction to Sustainable construction. Principles of sustainability. Major Environmental challenges, Global Warming. Introduction to Green Buildings Building energy system.

Strategies, Energy conservation in buildings. Energy Efficient projects. HVAC Systems. Water Conservation in buildings. Rainwater harvesting and management, Water Cycle strategies.		
Unit III	**Green Buildings**	**(8 Hours)**
Introduction, Green construction, Site selection for Green Construction, Design Considerations, Objectives of Green building movement. Green construction materials and resources. Material Selection Strategies. Eco-friendly Materials, Recyclable and Reusable Materials. Embodied Energy in Materials.		
Unit IV	**Introduction To Lean Principles**	**(7 Hours)**
Introduction — productivity measurement in projects and work diagnostics; Mapping of lean principles into construction; Lean construction — fundamental concepts; Lean thinking and culture;		
Unit V	**Project Life Cycle and Lean Project Delivery System**	**(7 Hours)**
Project life cycle and lean project delivery system; Lean tools, techniques and measures; Collaborative planning and last planner system; Location based management system;		
Unit VI	**Lean in Design and Lean Tools**	**(8 Hours)**
Lean in design and supply chain management; Lean enablers and integration; Application in lean project management software		

Learning Resources

Text Books:

1. Charles J. Kibert "Sustainable Construction: Green Building Design and Delivery" – 2016
2. Abe Kruger & Carl Seville "Green Building: Principles and Practices in Residential Construction" – 2012

Reference Books:

1. Green Building Design and Delivery, 2nd Edition, John Wiley, Hoboken -New Jersey.
2. Energy Efficient Buildings in India. Ed. Mujumdar Mili. TERI PRESS.
3. Energy efficient buildings in India. Case Studies by Teri. Video Cassettes, ds Shang Gao & Sui Pheng Low "Lean Construction Management: The Toyota Way" – 2014

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester IV

Course Type: PEC	**Course Title:** Pavement Recycling	
Course Code: 230GTEM17_04	**Teaching Scheme:**	**Examination Scheme:**
Credits: 3.0	**Lecture (L): 03** **Tutorial (T): --** **Practical (P): --** **Experiential Learning (EL): 00**	**CIE: 100 Marks** **ESE: 100 Marks**

Prerequisite Courses, if any:
1. Pavement Analysis and Design
2. Pavement Materials

Course Objective:
- To provide an understanding of the importance, methods, and types of pavement recycling techniques.
- To study the processes involved in the reclamation and reuse of asphalt pavement materials in bituminous road construction.
- To explore methods for recycling concrete pavement materials and their incorporation into new concrete construction.
- To impart knowledge on the design principles and testing methodologies for evaluating recycled pavement materials.
- To familiarize students with the equipment and machinery utilized in various pavement recycling processes.
- To examine real-world applications of pavement recycling and understand the factors influencing successful implementation.

Course Outcomes: On completion of the course, learner will be able to
CO1: Identify and explain various pavement recycling methods and their applicability in road construction.
CO2: Design and implement bituminous mixes incorporating RAP, considering appropriate processing and material proportioning.
CO3: Develop mix designs for concrete using recycled aggregates and assess their performance through laboratory testing.
CO4: Conduct laboratory tests to characterize recycled materials and ensure compliance with relevant standards.
CO5: Select and operate appropriate machinery for specific pavement recycling projects, ensuring safety and efficiency.
CO6: Analyze case studies to identify best practices and potential challenges in pavement recycling projects.

Course Contents

Unit I	**Introduction to Pavement Recycling**	**(8 Hrs)**

Necessity and benefits of pavement recycling, Types of pavement recycling: Hot In-Place Recycling (HIR), Cold In-Place Recycling (CIR), Hot In-Plant Recycling (HIP), Cold In-Plant Recycling (CIP), Overview of Reclaimed Asphalt Pavement (RAP) and Full Depth Reclamation (FDR).		
Unit II	**Reclaimed Asphalt Pavement (RAP) in Bituminous Pavements**	**(7 Hrs)**
Concept and properties of RAP, Milling operations and processing of RAP, Utilization of RAP in bituminous mixtures: Proportioning and mix design, Addition of virgin bitumen and rejuvenators, Field applications and case studies.		
Unit III	**Recycling of Concrete Pavements**	**(8 Hrs)**
Demolition techniques for concrete pavements, Processing of demolished concrete: Shredding and segregation, Use of recycled concrete aggregates (RCA) in new concrete mixes, Addition of cement and supplementary cementitious materials, Mix design procedures and laboratory testing for recycled concrete.		
Unit IV	**Design and Testing of Recycled Pavement Materials**	**(7 Hrs)**
Laboratory characterization of RAP and RCA, Performance testing of recycled mixes: Stability, durability, and strength assessments, Quality control measures during recycling operations, Standards and specifications for recycled materials.		
Unit V	**Equipment and Machinery for Pavement Recycling**	**(8 Hrs)**
Machinery used in milling and material processing, Equipment for in-place and in-plant recycling methods, Operational considerations and maintenance of recycling equipment, Safety protocols during recycling operations.		
Unit VI	**Field Implementation and Case Studies**	**(7 Hrs)**
Project planning and execution of pavement recycling, Analysis of successful pavement recycling projects, Challenges and solutions in field applications, Environmental and economic considerations in recycling.		

Learning Resources

Textbooks:

1. J. Paul Guyer, An Introduction to Asphalt Concrete Pavement Recycling, Paperback edition, 2016
2. Sze Wai Pan and Zhang Yifu, Research and Application of Hot in Place Recycling Technology for Asphalt Pavement (Woodhead Publishing Series in Civil and Structural Engineering), 2020.

Reference Books:

1. IRC 120: Recommended Practice for Recycling of Bituminous Pavements.
2. IRC SP: 101: Guidelines for Warm Mix Asphalt.
3. IRC SP: 79: Tentative Specification for Stone Matrix Asphalt. NHI Course No. 131050: Asphalt Pavement In-Place Recycling Techniques.
4. Pavement Analysis and Design by Yang H. Huang, Pearson Prentice Hall, 2004.

MOOC / NPTEL Courses for basic knowledge:

3. NPTEL Course "*Pavement Materials (Under Pavement Engineering)* ", By Prof. Nikhil Saboo, IIT Roorkee.
4. **Link of the Course:** https://onlinecourses.nptel.ac.in/noc22_ce93/preview

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester IV

Course Type: PEC	**Course Title:** Design of highway geometrics and drainage	
Course Code: 230GTEM18_04	**Teaching Scheme:**	**Examination Scheme:**
Credits: 3.0	**Lecture (L):** 03 **Tutorial (T):** -- **Practical (P):** -- **Experiential Learning (EL):** 00	**CIE:** 100 Marks **ESE:** 100 Marks

Prerequisite Courses, if any:
1. Traffic Engineering

Course Objective:

- Understand the functional classification of highways and the fundamental elements and design controls of highway geometric design
- Analyze and design sight distances considering safety and operational efficiency.
- Study the design of horizontal alignment of highways.
- Study the design of vertical alignment of highways.
- Understand the design steps involved in design of surface and subsurface drainage of highway pavements.
- To incorporate pedestrian, bicycle, and parking facilities into highway design, following IRC guidelines and specifications.

Course Outcomes: On completion of the course, learner will be able to

CO1: Classify highway systems and define design controls for cross-sectional elements, ensuring compliance with functional requirements.

CO2: Calculate and design stopping and overtaking sight distances, as well as sight distances at intersections for given conditions.

CO3: Design horizontal alignment features, including super-elevation, transition curves, and widening, ensuring stability and safety.

CO4: Design summit and valley curves and integrate horizontal and vertical alignments, adhering to comfort and safety standards.

CO5: Design surface and subsurface drainage systems and select filter materials and cross-drainage structures for efficient water management.

CO6: Demonstrate design principles of pedestrian, bicycle, bus bay, and parking facilities in compliance with IRC guidelines for urban settings.

Course Contents

Unit I	**Introduction**	**(8 Hrs)**

Introduction: Objectives of highway geometric design, elements of geometric design, design controls and criteria. Cross Section Elements: Pavement surface characteristics– skid resistance, cross slope, unevenness, light reflecting characteristics. Width considerations for carriageway, formation, shoulders, kerbs, traffic barriers, medians, frontage roads, right of way.

Unit II	**Sight Distance**	**(7 Hrs)**

Sight Distances: Types, analysis, factors affecting and design of stopping sight distance, intermediate sight distance, overtaking distance and Sight Distance at intersection.		
Unit III	**Horizontal Alignment**	**(8 Hrs)**
Horizontal Alignment: Design speed, stability at curves, analysis and design of super elevation, extra widening of pavements, design of transition curves.		
Unit IV	**Vertical alignment**	**(7 Hrs)**
Vertical alignment: Classification of grades, change of gradients, and design of summit curves for sight distance consideration, design of valley curves for comfort and sight distance considerations. Design standards for expressways and hill roads. IRC standards and guidelines.		
Unit V	**Highway drainage**	**(8 Hrs)**
Highway drainage: Significance and requirement of highway drainage- Design of surface drainage numerical and sub surface drainage system- numerical, Design of filter materials, types of cross drainage structures, their choice and location.		
Unit VI	**Miscellaneous Facilities**	**(7 Hrs)**
Miscellaneous Facilities: Pedestrian facilities on urban – types, IRC specification. Bicycle tracks -types, guidelines, and IRC design standards. Bus bays - types, guidelines and IRC design standards. Parking facilities - types, guidelines and IRC design standards.		

Learning Resources

Textbooks:

1. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., "*Highway Engineering*", Nem Chand and Bros, Roorkee.
2. L R Kadiyali, "*Highway Engineering*", Khanna Publishers, New Delhi.

Reference Books:

1. IRC 86:2018- Geometric Design Standards for Urban roads and streets.
2. IRC 73:1980- Geometric Design Standards for Rural roads.
3. AASHO,"*A Policy on Geometric Design of Highways and Streets*", American Association of State Highway and Transportation Officials, Washington D.C.

MOOC / NPTEL Courses for basic knowledge:

1. NPTEL Course "*Transportation Engineering I* ", Dr. Tom V Mathew, IIT Bombay
Link of the Course:https://nptel.ac.in/courses/105/101/105101087/

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester IV

Course Type: PROJ	**Lab Course Title:** Project	
Course Code: 240GTEM02_04	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 12	**Lecture (L):** **Tutorial (T):** **Practical (P):** 12 **Experiential Learning (EL):**24	**Oral (OR):** 300 Marks

Prerequisite Courses, if any: -

Objectives:

- To carry out in-depth field or technical investigation leading to solutions or recommendations.
- To validate methodology and refine approach through real-time analysis.
- To prepare for professional or research roles by developing complete project execution and communication skills.

Course Outcomes: On completion of the course, learner will be able to

CO1: Implement the methodology developed in Phase I.
CO2: Perform advanced analysis, modeling, or empirical study.
CO3: Interpret data and derive meaningful conclusions or insights.
CO4: Recommend practical solutions, strategies, or innovations.
CO5: Demonstrate professional reporting and presentation skills.
CO6: Exhibit teamwork, time management, and ethical standards.

Project Scope:

- Full-scale execution of field study/project/research.
- Data analysis, model testing, simulations (if applicable).
- Derivation of results, conclusions, and recommendations.
- Report writing in dissertation format.
- Final Seminar and Viva Voce.

Evaluation Criteria (Semester IV - 200 Marks):

1. Problem Definition and Continuity from Phase I
2. Execution of Methodology / Field Work / Simulation
3. Quality of Analysis, Interpretation, and Originality
4. Use of Tools, Software, or Data Modelling (if applicable)
5. Professional Project Report / Thesis Formatting
6. Interim Review Presentations
7. Final Seminar and Viva Voce
8. Discipline, Timeliness, Guide Feedback & Logbook

Instructions for Students (Phase II):

1. Work Execution
    - Carry out planned methodology including data collection, field visits, experiments, or case studies.
    - Use relevant tools, software, or modelling techniques as required.
2. Weekly Guidance & Reporting
    - Continue weekly updates to your guide and maintain project logbook.
    - Follow timelines and meet interim milestones.
3. Project Documentation
    - Your final report should include:
        - Cover Page
        - Abstract
        - Introduction
        - Literature Review
        - Methodology
        - Data Collection & Analysis
        - Results, Inferences, and Recommendations
        - Conclusion
        - References and Appendices
        - Plagiarism Check Certificate
4. Interim Review
    - Participate in mid-semester internal review to showcase progress and receive guidance.
5. Final Viva Voce
    - Present your complete project before the evaluation committee.
    - Answer queries based on your project's technical and practical aspects.
6. Professional Conduct
    - Ensure punctuality, discipline, ethical research practices, and regular communication with your guide.

JSPM University Pune
S.Y. M. Tech "Transportation Engineering"
Semester IV

Course Type: MLC	**Course Title:** Introduction to Indian Constitution	
Course Code: 230UPOB02_04	**Teaching Scheme:** (Hrs./Week)	**Examination Scheme:**
Credits: 1	**Lecture (L):** 1 **Tutorial (T):** 0 **Practical (P):** 0 **Experiential Learning (EL):** 0	**Theory (TH):** 50 Marks

Prerequisite Courses, if any: Nil

Course Objectives:

- To understand the historical context and constitutional development of India, including the impact of the colonial legacy and the role of the Constituent Assembly.
- To analyse the core principles of the Indian Constitution, including the Preamble, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, and their interrelationships.
- To examine the structure of the Indian government, the process of constitutional amendments, and the role of judicial review in upholding constitutional principles.

Course Outcomes: On completion of the course, learner will be able to

CO1: Remember- Recall the historical background, key events, and figures involved in the constitutional development of India.

CO2: Understand- Explain the significance of the Preamble and the fundamental principles of the Indian Constitution, such as sovereignty, secularism, socialism, and democracy.

CO3: Apply- Demonstrate an understanding of Fundamental Rights and Duties by identifying their applications and limitations in real-world scenarios.

CO4: Analyse- Analyse the relationship between Fundamental Rights and Directive Principles of State Policy, and how they interact to shape governance in India.

CO5: Evaluate- Assess the effectiveness of significant constitutional amendments and the role of judicial review in maintaining the integrity of the Indian Constitution.

CO6: Create- Develop a coherent argument or proposal for a constitutional amendment or policy change, grounded in the principles and structure of the Indian Constitution.

Course Contents		
Unit I	**Historical background**	**(3 Hrs)**
Colonial legacy, Constitutional development, The constituent assembly		
Unit II	**Preamble and fundamental principles**	**(2 Hrs)**
The Preamble, Sovereignty, Secularism, Socialism, and Democracy, Justice, Liberty, Equality, and Fraternity		
Unit III	**Fundamental Rights and Duties**	**(3 Hrs)**
Fundamental rights, Fundamental duties, Restrictions and amendments		
Unit IV	**Directive Principles of State Policy**	**(3 Hrs)**
Definition and purpose, Classification, Relationship with fundamental rights		
Unit V	**Organs of the Government**	**(2 Hrs)**
Union and state governments, The President and Prime minister, Parliamentary system		
Unit VI	**Amendments and Judicial Review**	**(2 Hrs)**
Amendment process, Significant amendments, Judicial review		

Learning Resources

Textbooks:

1. Basu, D. D., *Introduction to Constitution of India*, Prentice Hall of India, 1989
2. M. P. Jain, Indian Constitutional Law, LexisNexis, 2020

Reference Books:

1. Granville Austin The Indian Constitution: Cornerstone of a Nation, Oxford University Press, 1966
2. Mahendra Pal Singh, Shukla's Constitution of India, Eastern Book Company, 2019
3. Rajani Goyal, Modern Constitutions, RBSA Publications, 2023
4. Sukhbir Bhatnagar, Constitutional Law and the Governance, Mittal Publications, 2008

MOOC / NPTEL Courses:

1. Swayam: Constitutional Law **Link of the Course:** Constitutional Law, Aneeda Jan

Additional Web Resources: Constitution of India