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**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA**

**KAKINADA – 533 003, Andhra Pradesh, India**

## **DEPARTMENT OF CIVIL ENGINEERING**

### **COURSE STRUCTURE & SYLLABUS**

#### **M.Tech Transportation Engineering Programme**

*(Applicable for batches admitted from 2019-2020)*



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**


**I - Semester**

S.N o	Course No	Category	Course Name	L	T	P	C	Marks
1	MTEI-1	Core1	Advanced Highway Engineering	3	0	--	3	100
2	MTEI-2	Core2	Advanced Traffic Engineering	3	0	--	3	100
3	MTEI-3	Elective I		3	0	--	3	100
			a) Bridge Engineering					
			b) Project Management					
			c) Ground Improvement Technique					
4	MTEI-4	Elective II		3	0	--	3	100
			a) GIS for Transportation					
			b) Pavement Management System					
			c) Transportation Modeling and Simulation					
5	MTEMC		Research Methodology and IPR	2	0	0	2	100
6	MTEPI-1	Lab 1	Highway Aggregates Lab	-	--	4	2	100
7	MTEPI-2	Lab 2	Bituminous Testing Lab	-	--	4	2	100
8	MTEA-1	Audit Course –1		2	0	0	0	100
			<b>Total Credits /Marks</b>				<b>18</b>	<b>800</b>

**II - Semester**

S.No .	Course No	Category	Course Name	L	T	P	C	Marks
1	MTEII-1	Core 3	Pavement Analysis and Design	3	0	--	3	100
2	MTEII-2	Core 4	Transportation Planning	3	0	--	3	100
3	MTEII-3	Elective III		3	0	--	3	100
			a) Pavement Construction					
			b) Environmental Impact Assessment					
			c) Traffic Flow Analysis					
4	MTEII-4	Elective IV		3	0	--	3	100
			a) Geosynthetics and Reinforced Earth Structures					
			b) Highway Safety Engineering					
			c) Intelligent Transportation System					
5	MTEPII-1	Lab 3	Advanced Transportation Engineering Lab	--	--	4	2	100
6	MTEPII-2	Lab 4	Transportation Simulation Lab	--	--	4	2	100
7	MTEMP	Core	Mini Project with Seminar	0	0	4	2	100
8	MTEA-2	Audit Course -2		2	0	0	0	100
			<b>Total Credits /Marks</b>				<b>18</b>	<b>800</b>


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### III - Semester

S.No	Course No	Category	Course Name	L	T	P	C	Marks
1	MTEIII-1	Elective-V		3	0	--	3	100
			a)Financial and Economic Analysis of Transportation Projects					
			b)Airport Engineering					
			c)Transportation System Management					
2	MIEIII-2	Open Elective	Open Elective /MOOCS** a). Composite Materials b). Industrial Safety c). Operations Research	3	0	--	3	100
3	DISSERTATION	Core	Dissertation Phase-I / Industrial Project (To be continued and Evaluated next Semester)*	--	--	20	10	
<b>Total Credits /Marks</b>				<b>16</b>				<b>200</b>

\* Evaluated and displayed in 4<sup>th</sup> Semester marks list

\*\* Students Going for Industrial Project / Thesis will complete these courses through MOOCS

### IV - Semester

S. No.	Course No	Category	Course Name	L	T	P	C	Marks
1	DISSERTATION	Core	Dissertation Phase II (Continued from III Semester )	0	0	32	16	100
<b>Total Credits /Marks</b>							<b>16</b>	<b>100</b>

#### Audit course 1 & 2

1. English for Research PaperWriting
2. DisasterManagement
3. Sanskrit for TechnicalKnowledge
4. ValueEducation
5. Constitution of India
6. PedagogyStudies
7. Stress Management byYoga
8. Personality Development through Life EnlightenmentSkills.



I Year - I Semester		L	T	P	C
		3	0	0	3
Advanced Highway Engineering					

### UNIT –I

**Geometric Design of Highways:** Functional classification of Highway system; Design controls - Topography, Driver characteristics, Vehicle characteristics. Traffic, Capacity and Level of Service, Design speed. Objectives of Geometric Design. Road Margins - design specifications; Pavement surface characteristics - Skid Resistance, measurement of skid resistance; Road roughness, measurement of Road roughness; Camber design and standards.

### UNIT - II

**Horizontal and Vertical Alignment:** Sight Distance - SSD, OSD and ISD. Horizontal curves, Super elevation; computing of super elevation; attainment of super elevation; Extra widening on curves; Transition curves - Objectives and Design. Gradients - Types of Gradients, Design Standards; Summit Curves, Valley curves and Design criteria. Combination of Vertical and Horizontal curves - Grade Compensation. Importance of Sight Distances for Horizontal and Vertical curves.

### UNIT- III

**Design of Intersections:** Types of Intersections; Design Principles for Intersections; Design At-grade Intersections – Channelization, Objectives; Traffic Islands and Design standards Rotary Intersection - Concept, Advantages and Disadvantages; Grade separated Interchanges - Types, warrants and Design standards as per IRC.

### UNIT-IV

**Traffic Signs and Road Markings:** Types of Road Signs; Guidelines for the provision of Road Signs; Caution Signs, Regulatory signs. Information signs - Design standards. Road markings - Objectives of Road markings; Types of Road Marking, Role of Road markings in Road Safety and Traffic Regulation; Specification for Road Marking Highway Appurtenances-Delineators, Traffic Impact Attenuators, Safety Barriers.

### UNIT – V

**Pedestrian Elements:** Requirements of Pedestrians; Pedestrian facilities on Urban Roads; Cycle Tracks - Guidelines and Design standards; Bus bays-Types and Guide lines-Design of On street and Off street parking facilities - Guidelines for lay out Design. Design of Subways and foot over bridges.

### Suggested Reading

1. Principles and Practice of Highway Engineering, L.R.Kadiyali and N.B.Lal, Khanna Publications.
2. Text Book of Highway Engineering, R. Srinivasa Kumar, Universities Press, 2011.
3. Highway Engineering, C.E.G.Justo and S.K.Khanna, Nem Chand and Brothers
4. IRC Codes for signs, Markings and Mixed Traffic Control in Urban Areas.



I Year - I Semester		L	T	P	C
		3	0	0	3
Advanced Traffic Engineering					

#### UNIT-I

**Basic Aspects of Traffic Engineering** Aim of traffic engineering, traffic stream components and characteristics, road user characteristics, vehicle characteristics, acceleration characteristics, measures of quality, measures of separation, relationship among traffic parameters and empirical relationships, mechanics of traffic flow, macroscopic approach, microscopic approach and human factors approach, discrete distributions, binomial distribution, Poisson's distribution, exponential distribution, exponential distribution, normal distribution.

#### UNIT-II

**Traffic Studies, Measurement and Analysis;** Volume studies, speed studies, travel forecasting principles and techniques, design hourly volumes and speed, origin and destination studies, presentation of data and analysis, testing of hypothesis relating to improvements.

#### UNIT-III

**Travel Time amid Delay Studies;** Various uses, travel time and delay studies, various methods, data collection and analysis, density studies and headways, gap acceptance studies, intersection delay studies, traffic flow theory, queuing theory and simulation models.

#### UNIT-IV

**Capacity Analysis of Traffic Facilities;** Uninterrupted facilities, interrupted facilities, Level of Service, quality of service as per HCM, factors affecting LOS, computation of capacity and LOS, Measure of effectiveness, highway capacity and performance characteristics, intersection design.

#### UNIT-V

**Traffic Control, Design and Regulation;** Traffic signals, types, principles of phasing, tune diagram, signalized intersection, saturation flow, saturation headway, capacity of lane group, concept of critical lane group, signal timing, phase plan, phase diagram, splitting of phase, clearance interval, pedestrian requirement, guidelines for protected movements, signal co-ordination, emerging themes, inter-modalism, access management, congestion management, environmental impact assessment.

#### Suggested Reading

1. Introduction to Traffic Engineering, R. Srinivasa Kumar, Universities Press, 2018.
2. Highway Capacity Manual, Transportation Research Board, National Research Council, Washington, D.C., 2010.
3. Daganzo, C.R, Fundamentals of Transportation and Traffic Operations, Pergamon, Elsevier Science Inc., New York, 1997.
4. Salter, R.J., Traffic Engineering: Worked Examples, Macmillan, London, 1989.
5. Pignataro, L.J., Traffic Engineering: Theory and Practice, Prentice Hall, Englewood cliffs, 1973.
6. Wohl, M. and Martin, B.V, Traffic System Analysis for Engineers and Planners, McGraw Hill, New York, 1983.
7. Drew, D.R., Traffic Flow Theory, McGraw Hill, New York, 1964.



I Year - I Semester		L	T	P	C
		3	0	0	3
Bridge Engineering					

#### UNIT-I

Masonry arch Bridge design details- Rise, radius, and thickness of arch- Arch ring- Dimensioning of sub structures- Abutments pier and end connections.(Ref: IRC- SP-13)

#### UNIT-II

Super Structure: Slab bridge- Wheel load on slab- effective width method- slabs supported on two edges- cantilever slabs- dispersion length- Design of interior panel of slab- Pigeaud's method- design of longitudinal girders- Guyon-Messonet method- Hendry Jaegar method-Courbon's theory. (Ref: IRC-21), voided slabs, T-Beam bridges.

#### UNIT-III

Plate girder bridges- Elements of plate girder and their design-web-flange- intermediate stiffener- vertical stiffeners- bearing stiffener-design problem

#### UNIT-IV

Composite bridges- Composite action- shear connectors- composite or transformed section- design problem. (Ref: IRC:Section-VI)

#### UNIT-V

Sub structure- Abutments- Stability analysis of abutments- piers- loads on piers – Analysis of piers- Design problem(Ref: IRC-13, IRC-21, IRC-78)- Pipe culvert- Flow pattern in pipe culverts- culvert alignment- culvert entrance structure- Hydraulic design and structural design of pipe culverts- reinforcements in pipes .(Ref: IRC: SP-13)

#### REFERENCES:

1. Design of concrete bridges- Aswini, Vazirani, Ratwani
2. Essentials of bridge engineering- Jhonson Victor D

Design of bridges- Krishna Raju



I Year - I Semester		L	T	P	C
		3	0	0	3
Project Management					

### UNIT-I

**Introduction to Project Management:** A systems Approach, Systems Theory and Concepts, Organisation, Management Functions, Overview of Management Objectives, Tools and Techniques, Project Management – Processes and Organisational Structures – Team Management – Project Manager as a Team Leader – Leadership Qualities, PMIS.

### UNIT-II

**Construction Cost and Value Engineering:** Types of Estimates, Implementation of Cost Controls, Project Cost Forecasting, Cost Optimisation and Resources Planning - Value Engineering, Techniques for Project Selection, Break-Even Analysis, Cost Modelling, Energy Modelling, Life Cycle Cost Approach.

### UNIT-III

**Contract Management Safety in Construction Industry :** Tendering and Contracting, Laws of Contracts, subcontracts, Potential Problems, Post Contract Problems, Documents, Conditions, Arbitration, Special Features of International Contracts. Quality Management and Safety in Construction Industry - Quality control by statistical methods, sampling plan, control charts, ISO 14000, Safety Measures, Safety Programmes, Safety Awareness and Implementation of Safety Plan – Compensation.

### UNIT-IV

**Project Scheduling and Analysis Methods :** CPM, PERT, Linear programming, queuing concept, simulation, bidding models, game theory.

### UNIT-V

**Human Resource Management and Construction Management Practices :** Man Power Planning – Training – Motivation – Industrial Relations – Welfare Measures – MIS – Components and Structure – Personal Management. Resource Management and Inventory - Basic concepts, labour requirements & productivity, non-productive activities, site productivity, equipment and material management, inventory control. Construction Management Practices - Implementation of Procedures and Practices – International Experiences– Case Studies – Examples.

### REFERENCES:

1. Herold Kerzner - Project Management - A systems approach to Planning, Scheduling and Controlling. CBS Publishers and Distributors.
2. K. Waker A Teraih and Jose M. Grevan; Fundamentals of Construction Management and Organisations.
3. Anghel Patterson - Construction Cost Engineering Handbook - Marcel Dekken Inc.
4. Dell Isola - Value Engineering in Construction Industry, Van Nostrand Reinhold Co.,
5. Choudhary, S. Project Management, Tata McGraw Hill Publishing Co., Ltd.,
6. Raina UK, Construction management Practices, Tata McGrawhill Publishing Company Ltd.
7. Sengupta B and Guha H, Construction Management and Planning, Tata McGraw-Hill Publishing Company Limited, New Delhi.



I Year - I Semester		L	T	P	C
		3	0	0	3
Ground Improvement Technique					

#### UNIT- I

Introduction – Need for Engineering Ground – Classifications of Ground Modification Techniques – Suitability, Feasibility and Desirability. Densification of cohesionless soils – deep Compaction – Vibrofloation – Vibro Composer method Blasting – Densification at Ground. - Vibrocompaction - Heavy Tamping, Stability of foundation trenches and surrounding structures through soil Nailing.

#### UNIT-II

Stabilisation- Mechanical Stabilisation, Lime Stabilisation, CementStabilisation, Bitumen Stabilisation, Thermal Stabilisation and ChemicalStabilisation.

#### UNIT:-III

Dewatering and Grouting: - Dewatering methods – open sumps and ditches – gravity flow wells – Vacuum dewatering – Electro – kinetic dewatering – electrosmosis - Overview of grouting - Suspension grouts – Solution grouts – Methods of grouting – Grouting applications– Dams, Tunnels, Shafts and drifts, excavations.

#### UNIT-IV

Improvement of Cohesive soils – Preloading Soil Replacement – Radial Consolidation – Vertical and Radial Consolidation - Vertical Drains – Sand Drains – Effect of Smear – Sandwicks – Band drains – Dynamic Compaction.

#### UNIT-V

Stone Columns – Methods of installation of Stone Columns – Load shared by stone columns and the stabilized ground – uses of stone columns Lime columns and granular trenches – Installation – Improvements expected on Soil behavior. In situ ground reinforcement– ground anchors – types – Components and applications – uplift capability.

#### REFERENCE:

1. Construction and Geotechnical Methods in Foundation Engineering By R.M. Koerner, McGraw – Hill Book Co.
2. Current Practices in Geotechnical Engineering Vol.1, Alam Singh and Joshi, International Book Traders, Delhi, & Geo-Environ Academia.
3. Foundation Analysis and Design (1V Ed.) By J.E. Bowles, McGraw – Hill Book Co.,
4. Ground Improvement Techniques by P. Purushotham Raj, Laxmi Publications (P) Ltd., New Delhi.
5. Ground Improvement – Edited by M.P. Moseley, Blackie Academic & Professional.
6. Soil Mechanics for Road Engineers, H.M.S.O, London.
7. Ground Improvement Techniques by Bergado et al.





I Year - I Semester		L	T	P	C
		3	0	0	3
GIS for Transportation					

**UNIT-I**

Introduction to GIS: Introduction, GIS over view, use of GIS in decision making, Data processing, Components of GIS, The GIS and the organization.

**UNIT-II**

Data Input and Output: Data input - Key board entry, Remotely and sensed data, existing digital data, census related data sets, Data output - Hard copy and soft, copy devices.

**UNIT-III**

Data Quality and Data Management: Components of data quality - Micro level, Macro level components, Sources of error, A note about data accuracy. The data base approach, 3 classic data models, Nature of geographic data, Spatial data models, Databases for GIS.

**UNIT-IV**

GIS Analysis, Functions and Implementation: Organizing geographic data for analysis, Maintenance and analysis of the spatial data and non-spatial attribute data and its integration output formatting. Awareness, Developing system requirements, Evaluation of alternative systems, System justification and Development of an implementation plan, System acquisition and start up, Operation of the system.

**UNIT-V**

Application of GIS in Transportation Engineering : Intelligent information system for road accessibility study, GIS data base design for physical facility planning, Decision support systems for land use planning. GIS applications in environment impact assessment, GIS based Highway alignment, GIS based road network planning, GIS based traffic congestion analysis and accident investigation.

**REFERENCES:**

GIS A Management, Perspenfi Stan Aronoff, WDL Publisher.



I Year - I Semester		L	T	P	C
		3	0	0	3
Pavement Management System					

#### UNIT-I

**Introduction:** Definition -Components of Pavement Management Systems, Essential features. Pavement Management Levels and functions: Ideal PMS- Network and Project levels of PMS-Influence Levels- PMS Functions- Function of Pavement evaluation

#### UNIT-II

**Pavement Performance:** Serviceability Concepts- roughness-Roughness Components-Equipment-IRI - modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM and other models, comparison of different deterioration models.

#### UNIT-III

##### **Pavement Evaluation:**

**Functional Evaluation:** Functional and Structural deterioration models, unevenness prediction models and other models, comparison. Case studies.Equipments

**Structural Evaluation:-** Basics- NDT and Analysis—Condition Surveys-Distress-Destructive Structural Analysis- Application in Network andProject Levels

#### UNIT-IV

**Design Alternatives, Rehabilitation and Maintenance:** Design objectives and constraints, basic structural response models, physical design inputs, alternate pavement design strategies and economic evaluation, life cycle costing, analysis of alternate pavement strategies based on distress and performance, case studies. Equipments.Identification of Alternatives-Deterioration Modeling- Priority Programming Methods.

#### UNIT-V

**Expert Systems and Pavement Management:** Role of computers in pavement management, applications of expert systems for managing pavements, expert system for pavement evaluation and rehabilitation, knowledge-based expert systems, case studies.

#### TEXT BOOKS:

- 1.Ralph Haas and Ronald W. Hudson, 'Pavement Management System', McGraw Hill Book Co. 1978
- 2.Ralph Haas, Ronald Hudson Zanieswki. 'Modern Pavement Management, Kreiger Publications.
3. Proceedings of North American Conference on Managing Pavement .
- 4.Proceedings of International Conference on Structural Design of Asphalt Pavements NCHRP, TRR and TRB Special Reports



I Year - I Semester		L	T	P	C
		3	0	0	3
Transportation Modelling and Simulation					

### UNIT-1

**Introduction of Modeling:** Fundamentals of systemic approach. System modeling, Model structure, Variables, controllable variables, uncontrollable variables, parameters, coefficients and other statistical methods for testing of models and data.

### UNIT - II

**Classification of Models:** Classification of models - Linear models, Non-linear models, Time-invariant models, Time-variant models, State-space models, Distributed parameter models. System Synthesis- - Direct and Inverse Problems, Role of optimization and Examples from transportation engineering.

### UNIT-III

**Preliminary Data Processing:** data collection, Regression Analysis-Linear multiple regression analysis; Analysis of residues, Tests of goodness of fit. Spatial Distribution- Polynomial surfaces, Spline functions, Cluster analysis and Numerical production of contour maps. Time Series Analysis-Auto-cross correlation analysis, Identification of trend, spectral analysis, Identification of dominant cycles, smoothing techniques, Filters and forecasting.

### UNIT-IV

**Model Building:** Choice of Model Structure- A priori considerations, Selection based upon preliminary data analysis, Comparing model structures. Model Calibration- Role of historical data, Direct and Indirect methods of solving inverse problem.-Model Validation.

### UNIT-V

**Simulation;** Random variables, Basic concepts. Probability density and distribution functions, Expectation and standard deviation of discrete and continuous random variables and their functions, Covariance and correlation, commonly used theoretical Probability distributions: Uniform, Normal, Binomial, Poisson, Negative exponential. Fitting distributions to raw data: Chi-square and Kolmogorov-Smirnov's tests of the goodness of fit. Central limit theorem, various algorithms for generation of Random numbers. Queuing theory: Elements, Deterministic queues. Applications of Monte Carlo simulation: Basic concepts. Generation-of synthetic observations, - Statistical interpretation of the output, Evaluation of definite integrals and examples.

### References

1. Bratley, P., Fox B. L., Schrage, L. E. B., Guide to Simulation, Springer-Verlag, New York 1983.
2. Leigh, J. R., Modeling and Simulation, Peter Peregrinus, London, 1983.
3. Bernard, Z., Theory of Modeling and Simulation, John- Wiley, New York, 1976.
4. Ortuzar, J. and Willumsen, L.G, Modeling Transport, Wiley, Chinchestor, 1994.
5. Hansher, D. A., and Button. K. J., Handbook of Transport Modeling, Pergamon, Oxford, UK, 2000



I Year - I Semester		L	T	P	C
		3	0	0	3
Research Methodology and IPR					

### UNIT - I

**Research methodology:** Objectives and motivation of research - Types of research - Research approaches - Significance of research - Research methods verses methodology - Research and scientific method - Importance of research methodology - Research process - Criteria of good research - Problems encountered by researchers in India - Benefits to the society in general. Defining the research problem: Definition of research problem - Problem formulation - Necessity of defining the problem - Technique involved in defining a problem.

### UNIT – II

**Literature survey:** Importance of literature survey - Sources of information - Assessment of quality of journals and articles - Information through internet.

Literature review: Need of review - Guidelines for review - Record of research review.

### UNIT – III

**Research design:** Meaning of research design - Need of research design - Feature of a good design - Important concepts related to research design - Different research designs - Basic principles of experimental design - Developing a research plan - Design of experimental set-up - Use of standards and codes.

### UNIT – IV

**Data collection:** Collection of primary data - Secondary data - Data organization - Methods of data grouping - Diagrammatic representation of data - Graphic representation of data - Sample design - Need for sampling - Some important sampling definitions - Estimation of population - Role of statistics for data analysis - Parametric vs. non parametric methods - Descriptive statistics - Measures of central tendency and dispersion - Hypothesis testing - Use of statistical softwares.

Data Analysis: Deterministic and random data - Uncertainty analysis - Tests for significance - Chi-square - Student's t-test - Regression modeling - Direct and interaction effects – ANOVA - F-test - Time series analysis - Autocorrelation and autoregressive modeling.

### UNIT - V

**Research report writing:** Format of the research report – Synopsis – Dissertation - Thesis - Its differentiation – References – Bibliography – Webliography - Technical paper writing - Journal report writing - Making presentation - Use of visual aids.

Research proposal preparation: Writing a research proposal and research report - Writing research grant proposal.

### References:

1. C.R Kothari, "Research Methodology, Methods & Technique", New Age International Publishers, New Delhi, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, Chennai, 2011.
3. RatanKhananabis and SuvasisSaha, "Research Methodology", Universities Press, Hyderabad, 2015.
4. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publishing Pvt. Ltd., New Delhi, 2004.
5. Vijay Upagade and AravindShende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.
6. G. Nageswara Rao, "Research Methodology and Quantitative methods", BS Publications, Hyderabad, 2012.



I Year - I Semester		L	T	P	C
		0	0	4	2
Highway Aggregates Lab					

1. Aggregate tests.
2. Tests on sub grade soils.
3. Soil stabilization tests.
4. California Bearing Ratio Test
5. Soil Classification & Grain size analysis.
6. Mini project based on field and laboratory studies and data collected.

**Note:** All tests as per IS, ASTM, AASHTO, TRL, IRC procedures/specifications and guidelines



I Year - I Semester		L	T	P	C
		0	0	4	2
Bituminous Testing Lab					

1. Bitumen and Tar Tests as per IS code provisions.
2. Benkelman beam test
3. Stone Polishing Value test
4. International Roughness Index test
5. Mix design for Bituminous mixes
6. Falling Weight Deflectometer.
7. Mini project based on field and laboratory studies and data collected.

**Note:** All tests as per IS, ASTM, AASHTO, TRL, IRC procedures/specifications and guidelines



I Year - II Semester		L	T	P	C
		3	0	0	3
Pavement Analysis and Design					

**UNIT-I**

Pavement Types, Wheel Loads and Design Factors

Definition of Pavement Types, Comparison of Highway pavements, Wheel Loads, Tyre pressure, Contact pressure, Design Factors: Traffic and Loading, Environment, Materials, Failure criteria, Reliability.

**UNIT-II**
**Stresses in Pavements**

Layered System Concepts: One Layer System: Boussinesq Theory. Two Layer Theory: Burmister's Theory. Three Layer System. Stresses in Rigid Pavements. Relative Stiffness of Slabs, Modulus of Subgrade Reaction, Stresses due to Warping, Stresses due to Friction, Stresses due to Load, IRC Recommendations.

**UNIT-III**
**Pavement Design**

IRC Method of Flexible Pavement Design, AASHTO Method of Flexible Pavement Design, IRC Method for Rigid Pavements, use of Geosynthetics in pavements.

**UNIT-IV**
**Pavement Inventories**

Serviceability Concepts, Visual Rating, Pavement Serviceability Index, Roughness Measurements, Measurement of Distress Modes Cracking, Rutting, Rebound Deflection using Benkleman Beam Deflection Method, Load Man Concept, Skid Resistance Measurement.

**UNIT-V**
**Pavement Evaluation**

Functional Pavement Performance Evaluation: AASHTO Method, Psycho Physical and Psycho Metric Scaling Techniques, Deduct Value Method.

Beam Deflection Method, Pavement Distress Rating Technique. Design of Overlays by Benkelmen Beam Deflection Methods as per IRC – 81 - 1997 – pavements on problematic soils.

**REFERENCES:**

1. Yoder and Witzorack, "Principles of Pavement Design", John Willey and Sons.
2. Yang, H. Huang, "Pavement Analysis and Design", Prentice Hall Publication, Englewood Cliffs, New Jersey.
3. Sargious, M.A. Pavements and Surfacing for Highways and Airports  
– Applied science Publishers limited
4. Ralphs Hass and Hudson, W.R. "Pavement Management System" Mc-Graw Hill Book Company.
5. IRC codes of practice.





I Year - II Semester		L	T	P	C
		3	0	0	3
Transportation Planning					

**UNIT-I**

**Urban Transportation Problem Travel Demand:** Urban Issues, Travel Characteristics, Evolution of Planning Process, Supply and Demand– Systems approach. Travel Demand: Trends, Overall Planning process, Long term Vs Short term planning, Demand Function, Independent Variables, Travel Attributes, Assumptions in Demand Estimation, Sequential, and Simultaneous Approaches, Aggregate and Disaggregate Techniques.

**UNIT-II**

**Data Collection And Inventories:** Collection of data – Organisation of surveys and Analysis, Study Area, Zoning, Types and Sources of Data, Road Side Interviews, Home Interview Surveys, Commercial Vehicle Surveys, Sampling Techniques, Expansion Factors, Accuracy Checks, Use of Secondary Sources, Economic data – Income – Population – Employment – Vehicle Owner Ship.

**UNIT-III**

**Four Stage Demand Forecasting :** UTPS Approach, Trip Generation Analysis: Zonal Models, Category Analysis, Household Models, Trip Attraction models, Commercial Trip Rates. Trip Distribution: Growth Factor Methods, Gravity Models, Opportunity Models, Time Function Iteration Models.

**UNIT-IV**

**Mode Choice and Traffic Assignment :** Mode Choice Behaviour, Competing Modes, Mode Split Curves, Models and Probabilistic Approaches. Traffic Assignment: Basic Elements of Transport Networks, Coding, Route Properties, Path Building Criteria, Skimming Tree, All-or-Nothing Assignment, Capacity Restraint Techniques, Reallocation of Assigned Volumes, Equilibrium Assignment, Diversion Curves.

**UNIT-V**

**Plan Preparation And Evaluation:** Travel Forecasts to Evaluate Alternative Improvements, Impacts of New Development on Transportation Facilities. Master plans, Selection of Corridor, Corridor Identification, Corridor deficiency Analysis.

**REFERENCES:**

1. Introduction to Transportation Planning – M.J.Bruton; Hutchinson of London Ltd.
2. Introduction to Urban System Planning - B.G.Hutchinson; McGraw Hill.
3. Traffic Engineering and Transport Planning - Kadiyali L.R., Khanna Publishers
4. Lecture notes on UTP - Prof. S. Raghavachari ,R.E.C.Warangal.



I Year - II Semester		L	T	P	C
		3	0	0	3
Pavement Construction					

#### UNIT-I

**PAVEMENT CONSTRUCTION:** Preparation and Construction of Subgrade Soil, Subbase Courses, Base Courses, Bituminous Surface Courses, and Cement Concrete Surface Courses; MORTH specifications, Quality control..

#### UNIT-II

**PAVEMENT INVENTORIES AND EVALUATION:** Factors affecting Pavement Deterioration; Functional Condition Evaluation Techniques: Roughness Measurements, Identification of Uniform Sections, Serviceability Concepts: Visual & Ride Rating Techniques, Introduction to Psychometric and Psychophysical Scaling Techniques: Hutchinson's Tracking Task Device Structural Condition Evaluation Techniques: NDT Procedures, Rebound Deflection, Deflection Bowl Measurement and Analysis, Destructive Testing: Remaining Life Concept, Asphaltic Institute's Equivalency Factors

#### UNIT-III

**EVALUATION OF PAVEMENT SAFETY:** Importance of Skid Resistance, Factors Affecting Skid Resistance, Skid Resistance Studies, Hydroplaning Reduction with Porous Overlays & Popcorn Friction Overlays; Deterioration Modelling Concepts: Factors Influencing Structural & Functional Condition Deterioration, Examples of Initiation and Progressing Deterioration Models, Use of Deterioration Models by HDM Software

#### UNIT-IV

**PAVEMENT MAINTENANCE & QUALITY CONTROL:** Routine, Responsive Maintenance Programmes, Periodic Maintenance, Special Repairs, Rehabilitation and Reconstruction, Objectives & Components of Pavement Maintenance Management System (PMMS), Stages in Implementing PMMS, Total Quality Management (TQM): Quality Assurance/Quality Control Concepts, Sampling, Tolerances and Controls Related to Profile & Compaction, Role of ISO 9000 in TOM.

#### UNIT-V

**PAVEMENT MANAGEMENT SYSTEM (PMS):** Phases and Components of System's Approach, Relationship Between System Approach and PMS, Components and Activities of PMS, Inter-relationships between the different components of PMS, Steps in Implementing PMS, Pavement Investment Planning Approaches: Index Ranking, Benefit Maximization & Cost Minimization Methods, Evaluating Alternative Strategies and Decision Criteria Using HDM Package.

#### REFERENCES:

1. RCC Haas, W. Ronald Hudson, et al, Modern Pavement Management, Krieger Publishing Company
2. ISTE Summer School Report on PMSS by Bangalore University, ISTE, New Delhi.
3. Mohammed Y. Shahin, Pavement Management for Airports, Roads & Parking Lots, Chapman & Hall Publishers
4. Instructor's Guide-Asphalt Institute, Asphalt Technology and Construction Practices, Educational series
5. AF Stocks, Concrete Pavements, Elsevier Applied Science Publishers, New York
6. Harold N. Atkins, Highway Materials, Soils & Concrete 3rd Edition, Prentice Hall
- MORTH, GOI, "Specifications for Roads & Bridge Works", New Delhi



I Year - II Semester		L	T	P	C
		3	0	0	3
Environmental Impact Assessment					

**UNIT-I**

Introduction: Environment and its interaction with human activities – Environmental imbalances – Attributes, Impacts, ‘Indicators and Measurements - Concept of Environmental Impact Assessment (EIA), Environmental Impact Statement, Objectives of EIA, Advantages and Limitations

**UNIT-II**

Environmental Indicators - Indicators for climate - Indicators for terrestrial subsystems - Indicators for aquatic subsystems - Selection of indicators - Socio-economic indicators - Basic information - Indicators for economy - Social indicators - Indicators for health and nutrition - Cultural indicators - Selection of indicators.

**UNIT-III**

Environmental issues in water resource development - Land use - Soil erosion and their short and long term effects - Disturbance and long term impacts - Changes in quantity and quality of flow – Sedimentation – Environmental impact assessment of water resource development structures – Case studies, Water Quality Impact Assessment - Attributes, Water Quality, Impact Assessment of Water. Resources Projects, Data Requirements of Water Quality Impact Assessment for Dams, Impacts of Dams on Environment, Case Studies.

**UNIT-IV**

Environmental Issues in Industrial Development: On-site and Off-site impacts during various stages of industrial development, Long term climatic changes, Green house effect, Industrial effluents and their impact on natural cycle, Environmental impact of Highways, Mining and Energy development

**UNIT-V**

Methodologies for Carrying Environmental Impact Assessment: Overview of Methodologies .Adhoc, Checklist, Matrix, Network, Overlays, Benefit Cost Analysis, Choosing A Methodology, Review Criteria.

**REFERENCES:**

1. Jain, R.K., Urban, L.V., Stracy, G.S., (1991), “Environmental Impact Analysis”, Van Nostrand Reinhold Co., New York
2. Rau, J.G. and Wooten, D.C., (1996), “Environmental Impact Assessment”, McGraw Hill Pub.Co., New York
3. UNESCO, (1987), “Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development”, UNESCO/UNEP, Paris
4. Canter, L.W., (1997), “Environmental Impact Assessment”, McGraw Hill Pub. Co., New York.

I Year - II Semester		L	T	P	C
		3	0	0	3
Traffic Flow Analysis					

### UNIT-I

Traffic Flow Description: Traffic Stream Characteristics and Description Using Distributions: Measurement, Microscopic and Macroscopic Study of Traffic Stream Characteristics - Flow, Speed and Concentration; Use of Counting, Interval and Translated Distributions for Describing Vehicle Arrivals, Headways, Speeds, Gaps and Lags; Fitting of Distributions, Goodness of Fit Tests.

### UNIT-II

Traffic Stream Models: Fundamental Equation of Traffic Flow, Speed-Flow-Concentration Relationships, Normalised Relationship, Fluid Flow Analogy Approach, Shock Wave Theory - Flow-Density diagram use in Shockwave analysis; Use of Time-space diagram for shockwave description; Bottleneck situations and shockwaves; traffic signal and shockwave theory; numerical Examples for application of shockwave theory; Platoon Diffusion and Boltzman Like Behaviour of Traffic Flow, Car-Following Theory, Linear and Non-Linear Car-Following Models, Acceleration Noise, Fuel consumption models

### UNIT-III

Queuing Analysis: Fundamentals of Queuing Theory, Demand Service Characteristics, Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels, Analysis of M/M/1 system; Assumptions and Derivation of System State Equations; Application of M/M/1 analysis for parking Garages and Toll Plazas- numerical Examples; Analysis of D/D/1 system for delay characteristics; Traffic Signal analysis as D/D/1 system; Computation of delays and queue dissipation Time – Numerical Examples.

### UNIT-IV

Pedestrian Delays And Gaps: Pedestrian Gap acceptance and delays; Concept of Blocks, Anti-blocks, Gaps and Non-Gaps; Underwood's analysis for Pedestrian Delays; Warrants for Pedestrian Crossing Facilities – Minimum Vehicular Volume Warrant, Minimum Pedestrian Volume Warrant, Maximum Pedestrian Volume Warrant.

### UNIT-V

Simulation Models: Philosophy of Simulation Modelling, Formulation of Simulation Model, Methodology of System Simulation, Simulation Languages, Generation of Random Numbers, Generation of Inputs – Vehicle Arrivals, Vehicle Characteristics, Road Geometrics, Design of Computer Simulation Experiments, Analysis of Simulation Data, Formulation of Simulation Problems in Traffic Engineering and Validation.; Basic concepts of simulation modelling application for Signalised Intersections, Pedestrian Crossings and Transit scheduling.

### REFERENCES:

1. Traffic Flow Theory: A Monograph , TRB Special Report 165
2. Fundamentals of Transportation Engineering – C.S.Papacostas, Prentice Hall India Publication
3. Principles of Highway Engineering and Traffic Analysis – F.L.Mannering & W.P.Kilareski, John Wiley Publishers.



5. Fundamentals of Traffic Engineering – McShane& Rogers

I Year - II Semester		L	T	P	C
		3	0	0	3
Geosynthetics and Reinforced Earth Structures					

**UNIT-I**

**Geosynthetics and Properties and Testing Methods:** Introduction to Geosynthetics – Basic description – History – Manufacturing methods

- Uses and Applications. Properties and Testing methods of Geotextiles
- Geogrids – Geomembranes – Geocomposites.

**UNIT-II**

**Geotextiles:** Designing for Separation – Reinforcement – Stabilization

- Filtration – Drainage and Moisture barriers.

**UNIT-III**

**Geogrids:** Designing for Reinforcement – Stabilization – Designing Gabions – Construction methods – Design of retaining walls.

**UNIT-IV**

**Geomembranes:** Survivability Requirements – Pond Liners – Covers for Reservoirs – Canal Liners – Landfill Liners – Caps and closures – Dams and Embankments.

**Unit-V**

**Geocomposites:** Geocomposites – An added advantage – Geocomposites in Separation – Reinforcement – Filtration – Geocomposites as Geowebs and Geocells – Sheet drains – Strip drains and Moisture barriers.

**REFERENCES:**

- 1.“Designing with Geosynthetics by Robert M. KoernerPrantice Hall, Eaglewood cliffs, NJ 07632.
- 2.“Construction and Geotechnical Engineering using Synthetic Fabrics” by Robert M. Koerner and Josoph P. Welsh. John Willey and Sons, New York.
- 3.“Engineering with Geosynthetics”, by G. Venkatappa Rao and GVS SuryanarayanaRaju – Tata McGraw Hill Publishing Company Limited  
– New Delhi.
- 4.“Foundation Analysis and Design” by J.E. Bowles McGraw Hill Publications.



I Year - II Semester		L	T	P	C
		3	0	0	3
Highway Safety Engineering					

### UNIT I

#### Introduction to safety:

Road accidents, Trends, causes, Collision diagrams; Highway safety; Human factors and road user limitations; Speed and its effect on road safety; Vehicle factors; Highway safety in India. Multi-causal dynamic systems approach to safety; Crash Vs Accident; Road safety improvement strategies; Elements of a road safety plan, Safety data Needs; Safe vehicle design.

### UNIT II

#### Statistical Interpretation and Analysis of Crash Data:

Before-after methods in crash analysis, Recording of crash data; Accident Investigation and Analysis; Statistical testing and the role of chance; Black Spot Identification and Investigations, Case Studies.

### UNIT III

#### Road Safety Audits:

Key elements of a road safety audit, Road Safety Audits & Investigations, Work zone safety audit; Crash investigation and analysis, Methods for identifying hazardous road locations, Case Studies.

### UNIT IV

#### Crash Reconstruction:

Describe the basic information that can be obtained from the roadway surface, Understand basic physics related to crash reconstruction, speed for various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes, Case Studies.

### UNIT V

#### Mitigation Measures:

Accident prevention by better planning, Accident prevention by better design of roads, Crash Countermeasures, Highway operation and accident control measures, Highway Safety Measures during construction, Highway geometry and safety; Safety in urban areas; Public transport and safety; Road safety policy making, Stakeholders involvement; Road safety law.

### References:

1. AthelstanPopkess, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997 (Digitized 2008)
2. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997 (reprinted 2002).
3. GeetamTiwari and Dinesh Mohan, Transport Planning and Traffic Safety: Making Cities, Roads, and Vehicles Safer, CRC Press, 2016.
4. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.
5. J. Stannard Baker, Traffic Collision Investigation, Northwestern University Center for Public Safety, 2002.
6. Ken W. Ogden, Safer Roads: A Guide to Road Safety Engineering. Avebury Technical, 1996.
7. Leonard Evans, Traffic Safety, Science Serving Society, 2004.
8. Lynn B. Fricke, Traffic Crash Reconstruction, Second Edition, Northwestern University Center for Public Safety, 2010.
9. Rune Elvik and TrulsVaa, The Handbook of Road Safety Measures, Elsevier, 2004.
10. Towards Safe Roads in Developing country. TRL – ODA, 2004.
11. IRC:SP:55-2014 Guidelines of Traffic Management in work zones
12. IRC:SP:88-2019 Manual on Road Safety





I Year - II Semester		L	T	P	C
		3	0	0	3
Intelligent Transportation System					

#### UNIT-I

**Fundamentals of ITS:** Definition of ITS, The historical context of ITS from both public policy and market economic perspectives, Types of ITS; Historical Background, Benefits of ITS

#### UNIT-II

**Sensor technologies and Data requirements of ITS:** Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centres; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts; ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), GIS, video data collection

#### UNIT-III

**ITS functional areas** – 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).

ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

#### UNIT-IV

**ITS Architecture** – Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods; Planning and human factor issues for ITS, Case studies on deployment planning and system design and operation; ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS planning

#### UNIT-V

**ITS applications:** Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations; commercial vehicle operations and intermodal freight; public transportation applications; ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions Automated Highway Systems- Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries

#### REFERENCES:

1. Fundamentals of intelligent transportation systems planning By Mashrur A. Chowdhury, Adel Wadid Sadek
2. Lawrence A. Klein, Sensor technologies and Data requirements of ITS
3. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
4. Sussman, J. M., Perspective on ITS, Artech House Publishers, 2005.
5. National ITS Architecture Documentation, US Department of Transportation, 2007





I Year - II Semester		L	T	P	C
		0	0	4	2
Advanced Transportation Engineering Lab					

1. Volume Studies – Straight Roads and at Intersections
2. Speed Studies - Spot Speed Studies by Stop Watch, Enoscope and Radar Speed Meter
3. Journey Time and Delay Studies - Floating Car Method
4. Parking Surveys and Parking Turnover Studies
5. Study of Gaps and Lags – Critical Gaps and Lags at Intersections
6. Delay Measurement at Signalised and Unsignalised Intersections
7. Traffic Diversion Analysis using diversion curves.
8. Videography Survey.
9. Road safety Audit.
10. Mini Project based on above studies.



I Year - II Semester		L	T	P	C
		0	0	4	2
Transportation Simulation Lab					

1. Driver testing Experiments
2. Intersection designs
3. Signal Design.
4. Origin and Destination Studies
5. Computer Software: Principles of TRIPS, CUBE, Demo Versions, Case studies.
6. Traffic Simulation studies using VISSIM.
7. Cellular applications.
8. Accident Studies.



II Year - I Semester		L	T	P	C
		3	0	0	3
Financial and Economic Analysis of Transportation Projects					

#### UNIT – I

**Transportation Projects Formulation and Development:** Requirements in project formulation. Components of project, Non- monetary and monetary Criteria in formulation of project. Decision making Criteria input in Project formulation. Preparation of DPR – Guidelines Transport Projects and development: preparation of Project, Highway Planning, Traffic infrastructure, Project formulation, Road Network project development

#### UNIT- II .

**Economic evaluation of Transportation plans:** Need for Economic Evaluation; Principles of economic evaluation; Welfare economics; Social costs, Vest change, Rate of return. Value of Travel time Savings; Economic concept of evaluation of travel time savings, Issues connected with evaluation of travel time savings. Vehicle operating costs; Components of VOC, Road user Cost study in India; Accident costs; Methodologies for economic evaluation of an accident; Factors involved.

#### UNIT-III

**Methods of Economic Analysis:** Cash flow diagrams, Time value of money, Inflation, Interest, Depreciation, Cost and benefit components, discounting criteria. Equivalent Uniform Annual cost Method; Present worth of cost method; Equivalent uniform annual net return method; Net-present value method; Benefit cost ratio method; Rate of Return Method; Application of these methods to numerical examples.

#### UNIT-IV

**Analysis of variable costs and Transportation Asset Management:** Types of Capital Financing; valuation; Project appraisal by shadow pricing with case studies. Economic Analysis of BOT and BOOT projects and allocations. Introduction and scope of asset management in India.

#### UNIT-V

**Environmental Impact Assessment:** Basic concepts, Objectives, Transportation related Environmental Impacts - Vehicular Impacts - Safety and Capacity Impacts - Roadway Impacts – Construction Impacts, Environmental Impact Assessment-Environmental Impact Statement, Environment Audit, Typical case studies.

#### References

1. Transportation Engineering Economics - Heggie. I.G., McGraw Hill Publishers.
2. Economic Analysis for Highways - Winfrey. R; International Text Book Company.
3. Traffic Engineering and Transport Planning - L. R. Kadiyali, Khanna Publishers.
4. Road User Cost Study, CRRI.
5. Road Project Appraisal for Developing Countries, J. W. Dickey, John Wiley & Sons.
6. Construction Management & Planning, B.Sengupta, H.Guha, Tata McGraw Hill, New Delhi



II Year - I Semester		L	T	P	C
		3	0	0	3
Airport Engineering					

#### UNIT-I

**Airport Planning:** Growth of Air Transport, Technological Developments, Institutional Development for Planning, Regulatory Practices; Aircraft characteristics related to airport planning and design, Future trends in Air craft design and Airport Planning; Airport master plan, site selection, planning surveys etc. Airport Obstructions: Zoning Laws, Classification, Approach and Turning Zones.

#### UNIT-II

**Runway Design and Airport Capacity:** Runway Orientation, Basic Runway Length and Factors affecting, Correction for elevation, temperature and gradient as per ICAO and FAA, Run way Geometric Design. Airport Capacity: Classification and Standards; Capacity of Airport, Runway, Taxiway and Gate; Delays; Configuration of Airport and Configuration; Runway Intersection Design; Terminal Facilities and Standards; Planning Concepts. Taxiway Design: Factors affecting Taxiway Design, Geometric Design as per ICAO, Exit taxiways, Fillets, Separation clearance, Holding Apron, Turn Around.

#### UNIT-III

**Design of Airport Pavements:** Design factors, Calculation of ESWL with different wheel load configurations and methods, Repetition of loads, failure criteria; Flexible Pavements Design: US corps of Engineers Method, FAA method; Rigid Pavement Design methods: US corps of Engineers method, PCA Method, FAA method, LCN Method and CAN-PCN System.; Overlays; Drainage: Surface and subsurface methods, filter materials, Special characteristics and requirements of Airport Drainage. Airfield Pavement Maintenance and Rehabilitation: Need, Failures, Evaluation of flexible and Rigid Pavements, Strengthening of Airfield Pavements and maintenance operations.

#### UNIT-IV

**Air Travel Demand Analysis:** The Demand Analysis, Microanalysis of Air Travel Demand, Calibration of Macro analysis of Air Travel Demand, Disaggregate Models Route Frequency planning. Air travel choice Models, Simultaneous Models of Demand and supply. Optimal Route Frequency Planning.

#### UNIT-V

**Air Traffic Controls (ATC):** Visual Aids: marking and lighting; Need, Network and Aids for ATC, Radio equipment; Design of Heliports and STOLPORTS: Design Factors, Planning, Site selection. Geometric Designs, Visual Aids.

#### References

1. Principles of Pavement Design, Yoder E.J. and Witczak M. W. John Wiley &-Sons, 1975.
2. Elementary Hand Book of Aircraft Engines, A. W. Judge, Chapman and Hall ltd, London.
3. Airplanes Structures, A.S. Niles and J.S. Newell, M. W. John Wiley & Sons, New York.
4. Transportation Engineering- Airports, Railways, Docks & Harbours, R, Srinivasa Kumar, Universities Press, 2014.
5. Air Port Engineering, Norman Ashford and Paul H Wright, M.W. John Wiley & Sons.



II Year - I Semester		L	T	P	C
		3	0	0	3
Transportation System Management					

**UNIT-I**

**TRAFFIC REGULATIONS:** Purpose and Scope, One way streets; reversible lanes and road ways; Turn regulations, Transit and Carpool lanes, Bicycle lanes and Bikeways, Pedestrian only streets, Speed Regulations, Passing and No Passing Regulations; Stop and yield controls.

**UNIT-II**

**TRAFFIC MANAGEMENT:** Need for Traffic Management, Basic Traffic Management Activities, Traffic Management Strategies and their Co-ordination; Access Management, Congestion Management, Traffic Calming, Evaluation of Traffic Management Systems.

**UNIT-III**

**TRANSPORTATION SYSTEM MANAGEMENT:** Objectives, Need for TSM Long – Range vs. TSM Planning; TSM Actions, Traffic Management Techniques for improving Vehicular Flows, Preferential Treatment for High Occupancy Modes; Promoting Non- Auto and High Occupancy Vehicles; Transit and Intermediate public Transport service improvements, Demand Management Techniques for Reduced Intermediate Public Transport service improvements, Demand Management Techniques for Reduced Traffic Demand, Staggered Working Hours, Vehicular Restrictions, Intersection management techniques- Signal Progression – Optimization.

**UNIT-IV**

**LOCAL AREA TRAFFIC MANAGEMENT:** Pedestrian Facilities; Bicycle Facilities; Traffic Planning and Management at Local Level; Individual Sites, Residential Neighbourhoods and local interests, Traffic Effects of Land Use Developments.

**UNIT-V**

**TRAFFIC ADMINISTRATION:** Legislative Authority; Functional Responsibilities; Organization-UMTA-State Highway Department; Traffic Records; Research Bodies; Citizen Participation; Asset Management.

**REFERENCES:**

1. Institution of Transportation Engineers. Traffic Engineering Hand Book, 4 th ed., Prentice Hall
2. Transportation System Management ,State of the Art, UMTA, USDOT
3. Khisty CJ and BK Lall, Transportation Engineering: An Introduction Prentice Hall International, Inc
4. Local Area Traffic Management, TRB Special Publications.

II Year - I Semester		L	T	P	C
		3	0	0	3
<b>Open Elective: a). COMPOSITE MATERIALS</b> (Common to M. Tech - Soil Mechanics & Foundation Engineering, Highway Engineering, Transportation Engineering, and Environmental Engineering )					

### Course Outcome:

At the end of the course the students will be able to:

- Use of different material to design composites
- Use of different techniques to process different types of composites and know the limitations of each process.
- Understand and describe the basic concept and classification of composite.
- Acquire the knowledge in polymer matrix composites and its processing methods.
- Acquire the knowledge in metal matrix composites and its processing methods.
- Acquire the knowledge in ceramics matrix composites and its processing methods.

### UNIT I

**INTRODUCTION:** Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

### UNIT II

**REINFORCEMENTS:** Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

### UNIT III

**Manufacturing of Metal Matrix Composites:** Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. **Manufacturing of Ceramic Matrix Composites:** Liquid Metal Infiltration – Liquid phase sintering. **Manufacturing of Carbon – Carbon composites:** Knitting, Braiding, Weaving. Properties and applications.

### UNIT IV

**Manufacturing of Polymer Matrix Composites:** Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

### UNIT V

**Strength:** Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hydrothermal failure. Laminate first ply failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

### REFERENCES:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
3. Hand Book of Composite Materials-ed-Lubin.
4. Composite Materials – K.K.Chawla.
5. Composite Materials Science and Applications – Deborah D.L. Chung.
6. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

II Year - I Semester		L	T	P	C
		3	0	0	3
Open Elective: b). INDUSTRIAL SAFETY					
(Common to M. Tech - Soil Mechanics & Foundation Engineering, Highway Engineering, Transportation Engineering, and Environmental Engineering )					

#### OUTCOMES:

- Student can know how to take safety measures in executing works
- Can identify the need for maintenance (or) replacement of equipment
- Can understand the need for periodic and preventive maintenance

#### UNIT-I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

#### UNIT-II

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

#### UNIT-III

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

#### UNIT-IV

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.





## UNIT-V

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance. Repair cycle concept and importance.

## REFERENCE:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

[www.FirstRanker.com](http://www.FirstRanker.com)

II Year - I Semester		L	T	P	C
		3	0	0	3
Open Elective: c). OPERATIONS RESEARCH (Common to M. Tech - Structural Engineering & Structural Design, Soil Mechanics & Foundation Engineering, Highway Engineering, and Transportation Engineering)					

## OUTCOMES:

At the end of the course, the student will be able to

- Formulate a linear programming problem for given problem and solve this problem by using Simplex techniques
- apply the dynamic programming to solve problems of discrete and continuous variables
- apply the concept of non-linear programming for solving the problems involving non-linear constraints
- carry out sensitivity analysis
- model the real world problem and simulate it

## UNIT-I

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

## UNIT-II

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.

## UNIT-III

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.

## UNIT-IV

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

## UNIT-V

Competitive Models, Single and Multi-Channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

## REFERENCE:

1. KanthiSwarup, P.K. Gupta and Man Mohan, Operations Research, 14 th Edition, Sultan Chand and Sons, New Delhi, 2008.
2. S. D. Sharma, Operations Research, KedarNath and Ram Nath, Meerut, 2008.
3. H.A. Taha, Operations Research, An Introduction, PHI, 2008
4. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
5. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
6. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
7. Pannerselvam, Operations Research: Prentice Hall of India 2010
8. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

### AUDIT 1 and 2: ENGLISH FOR RESEARCH PAPER WRITING

<b>Course objectives:</b> Students will be able to: Understand that how to improve your writing skills and level of readability Learn about what to write in each section Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission		
<b>Syllabus</b>		
Units	CONTENTS	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	4
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	4
5	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	4
6	useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	4

#### Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

### AUDIT 1 and 2: DISASTER MANAGEMENT

**Course Objectives:** -Students will be able to:  
 learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.  
 critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.  
 develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.  
 critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

#### Syllabus

Units	CONTENTS	Hours
1	<b>Introduction</b> Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	4
2	<b>Repercussions Of Disasters And Hazards:</b> Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	4
3	<b>Disaster Prone Areas In India</b> Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	4
4	<b>Disaster Preparedness And Management</b> Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	4
5	<b>Risk Assessment</b> Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	4
6	<b>Disaster Mitigation</b> Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	4

#### Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies ""New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

**AUDIT 1 and 2: SANSKRIT FOR TECHNICAL KNOWLEDGE****Course Objectives**

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

**Syllabus**

Unit	Content	Hours
1	<ul style="list-style-type: none"><li>• Alphabets in Sanskrit,</li><li>• Past/Present/Future Tense,</li><li>• Simple Sentences</li></ul>	8
2	<ul style="list-style-type: none"><li>• Order</li><li>• Introduction of roots</li><li>• Technical information about Sanskrit Literature</li></ul>	8
3	<ul style="list-style-type: none"><li>• Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics</li></ul>	8

**Suggested reading**

1. “Abhyaspustakam” – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.

**Course Output**

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

**AUDIT 1 and 2: VALUE EDUCATION****Course Objectives**

Students will be able to

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

**Syllabus**

Unit	Content	Hours
1	<ul style="list-style-type: none"><li>• Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.</li><li>• Moral and non- moral valuation. Standards and principles.</li><li>• Value judgements</li></ul>	4
2	<ul style="list-style-type: none"><li>• Importance of cultivation of values.</li><li>• Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.</li><li>• Honesty, Humanity. Power of faith, National Unity.</li><li>• Patriotism.Love for nature ,Discipline</li></ul>	6
3	<ul style="list-style-type: none"><li>• Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline.</li><li>• Punctuality, Love and Kindness.</li><li>• Avoid fault Thinking.</li><li>• Free from anger, Dignity of labour.</li><li>• Universal brotherhood and religious tolerance.</li><li>• True friendship.</li><li>• Happiness Vs suffering, love for truth.</li><li>• Aware of self-destructive habits.</li><li>• Association and Cooperation.</li><li>• Doing best for saving nature</li></ul>	6
4	<ul style="list-style-type: none"><li>• Character and Competence –Holy books vs Blind faith.</li><li>• Self-management and Good health.</li><li>• Science of reincarnation.</li><li>• Equality, Nonviolence ,Humility, Role of Women.</li><li>• All religions and same message.</li><li>• Mind your Mind, Self-control.</li><li>• Honesty, Studying effectively</li></ul>	6

**Suggested reading**

1 Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

**Course outcomes**

Students will be able to 1.Knowledge of self-development

2.Learn the importance of Human values 3.Developing the overall personality

## AUDIT 1 and 2: CONSTITUTION OF INDIA

### Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

### Syllabus

Units	Content	Hours
1	<b>•History of Making of the Indian Constitution:</b> History Drafting Committee, ( Composition & Working)	4
2	<b>•Philosophy of the Indian Constitution:</b> Preamble Salient Features	4
3	<input type="checkbox"/> <b>Contours of Constitutional Rights &amp; Duties:</b> <input type="checkbox"/> Fundamental Rights <input type="checkbox"/> Right to Equality <input type="checkbox"/> Right to Freedom <input type="checkbox"/> Right against Exploitation <input type="checkbox"/> Right to Freedom of Religion <input type="checkbox"/> Cultural and Educational Rights <input type="checkbox"/> Right to Constitutional Remedies <input type="checkbox"/> Directive Principles of State Policy <input type="checkbox"/> Fundamental Duties.	4
4	<input type="checkbox"/> <b>Organs of Governance:</b> <input type="checkbox"/> Parliament <input type="checkbox"/> Composition <input type="checkbox"/> Qualifications and Disqualifications <input type="checkbox"/> Powers and Functions <b>• Executive</b> <input type="checkbox"/> President <input type="checkbox"/> Governor <input type="checkbox"/> Council of Ministers <input type="checkbox"/> Judiciary, Appointment and Transfer of Judges, Qualifications <input type="checkbox"/> Powers and Functions	4
5	<input type="checkbox"/> <b>Local Administration:</b> <input type="checkbox"/> District's Administration head: Role and Importance, <input type="checkbox"/> Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. <input type="checkbox"/> Pachayati raj: Introduction, PRI: ZilaPachayat. <input type="checkbox"/> Elected officials and their roles, CEO ZilaPachayat: Position and role. <input type="checkbox"/> Block level: Organizational Hierarchy (Different departments), <input type="checkbox"/> Village level: Role of Elected and Appointed officials, <input type="checkbox"/> Importance of grass root democracy	4



<b>6</b>	<input type="checkbox"/> <b>Election Commission:</b> <input type="checkbox"/> Election Commission: Role and Functioning. <input type="checkbox"/> Chief Election Commissioner and Election Commissioners. <input type="checkbox"/> State Election Commission: Role and Functioning. <input type="checkbox"/> Institute and Bodies for the welfare of SC/ST/OBC and women.	<b>4</b>
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### Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

### Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

### AUDIT 1 and 2: PEDAGOGY STUDIES

**Course Objectives:**

Students will be able to:

4. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
5. Identify critical evidence gaps to guide the development.

**Syllabus**

Units	Content	Hours
1	<ul style="list-style-type: none"> <li>□ <b>Introduction and Methodology:</b></li> <li>□ Aims and rationale, Policy background, Conceptual framework and terminology</li> <li>□ Theories of learning, Curriculum, Teacher education.</li> <li>□ Conceptual framework, Research questions.</li> <li>□ Overview of methodology and Searching.</li> </ul>	4
2	<ul style="list-style-type: none"> <li>• Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.</li> <li>• Curriculum, Teacher education.</li> </ul>	2
3	<ul style="list-style-type: none"> <li>• Evidence on the effectiveness of pedagogical practices</li> <li>• Methodology for the in depth stage: quality assessment of included studies.</li> <li>• How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?</li> <li>• Theory of change.</li> <li>• Strength and nature of the body of evidence for effective pedagogical practices.</li> <li>• Pedagogic theory and pedagogical approaches.</li> <li>• Teachers' attitudes and beliefs and Pedagogic strategies.</li> </ul>	4
4	<ul style="list-style-type: none"> <li>• Professional development: alignment with classroom practices and follow-up support</li> <li>• Peer support</li> <li>• Support from the head teacher and the community.</li> <li>• Curriculum and assessment</li> <li>• Barriers to learning: limited resources and large class sizes</li> </ul>	4
5	<ul style="list-style-type: none"> <li>□ <b>Research gaps and future directions</b></li> <li>□ Research design</li> <li>□ Contexts</li> <li>□ Pedagogy</li> <li>□ Teacher education</li> <li>□ Curriculum and assessment</li> <li>□ Dissemination and research impact.</li> </ul>	2

**Suggested reading**

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. [www.pratham.org/images/resource%20working%20paper%202.pdf](http://www.pratham.org/images/resource%20working%20paper%202.pdf).

**Course Outcomes:**

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

## AUDIT 1 and 2: STRESS MANAGEMENT BY YOGA

### Course Objectives

1. To achieve overall health of body and mind
2. To overcome stress

### Syllabus

Unit	Content	Hours
1	<ul style="list-style-type: none"> <li>Definitions of Eight parts of yog. ( Ashtanga )</li> </ul>	8
2	Yam and Niyam. Do`s and Don`t`s in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
3	<ul style="list-style-type: none"> <li>Asan and Pranayam</li> <li>1. Various yog poses and their benefits for mind &amp; body</li> <li>2. Regularization of breathing techniques and its effects-Types of pranayam</li> </ul>	8

### Suggested reading

1. ‘Yogic Asanas for Group Training-Part-I’ :Janardan Swami YogabhyasiMandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

### Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

## AUDIT 1 and 2: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

### Course Objectives

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

### Syllabus

Unit	Content	Hours
1	Neetisatakam-Holistic development of personality <ul style="list-style-type: none"> <li>• Verses- 19,20,21,22 (wisdom)</li> <li>• Verses- 29,31,32 (pride &amp; heroism)</li> <li>• Verses- 26,28,63,65 (virtue)</li> <li>• Verses- 52,53,59 (don't's)</li> <li>• Verses- 71,73,75,78 (do's)</li> </ul>	8
2	<ul style="list-style-type: none"> <li>• Approach to day to day work and duties.</li> <li>• Shrimad BhagwadGeeta : Chapter 2-Verses 41, 47,48,</li> <li>• Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,</li> <li>• Chapter 18-Verses 45, 46, 48.</li> </ul>	8
3	<ul style="list-style-type: none"> <li>• Statements of basic knowledge.</li> <li>• Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68</li> <li>• Chapter 12 -Verses 13, 14, 15, 16,17, 18</li> <li>• Personality of Role model. Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42,</li> <li>• Chapter 4-Verses 18, 38,39</li> <li>• Chapter18 – Verses 37,38,63</li> </ul>	8

### Suggested reading

1. “Srimad Bhagavad Gita” by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

### Course Outcomes

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.