

COURSE STRUCTURE AND SYLLABUS
of
Master of Technology
in
Transportation Engineering

Effective from Academic Session 2023-24



DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF ENGINEERING AND TECHNOLOGY
CENTRAL UNIVERSITY OF JHARKHAND, CHERI-
MANATU
RANCHI - 835 222, JHARKHAND

First Semester

| Sl. No | Course Title | | Periods Per Week | | | Credit |
|--------|-----------------------------------------------------|---------------|------------------|----------|----------|----------|
| | | | L | T | P | |
| 1. | Pavement Materials | TEN611010 | 3 | 0 | 0 | 3 |
| 2. | Urban Transport System Planning | TEN 611020 | 3 | 0 | 0 | 3 |
| 3. | Elective – I | | 3 | 0 | 0 | 3 |
| | Geometric Design of Transportation Facility | TEN 616010 | 3 | 0 | 0 | 3 |
| | Airport Engineering | TEN 616020 | 3 | 0 | 0 | 3 |
| | Intelligent Transport System | TEN 616030 | 3 | 0 | 0 | 3 |
| | GIS application in Transportation Engineering | TEN 616040 | 3 | 0 | 0 | 3 |
| 5. | Elective – II | | 3 | 0 | 0 | 3 |
| | Pavement Geotechniques | TEN 616050 | 3 | 0 | 0 | 3 |
| | Pavement Evaluation, Rehabilitation and Maintenance | TEN 616060 | 3 | 0 | 0 | 3 |
| | Project Management | TEN 616070 | 3 | 0 | 0 | 3 |
| | Climate Change and Sustainable Development | TEN 616080 | 3 | 0 | 0 | 3 |
| 6. | Elective – III | | 3 | 0 | 0 | 3 |
| | Environmental Impact Assessment | TEN 616090 | 3 | 0 | 0 | 3 |
| | Finite Element Method and Analysis | TEN616100 | 3 | 0 | 0 | 3 |
| | Design and Maintenance of Low Volume Road | TEN 616110 | 3 | 0 | 0 | 3 |
| | Railways and Waterways | TEN 616120 | 3 | 0 | 0 | 3 |
| 7. | Research Methodology and IPR | TEN 611030 | 2 | 0 | 0 | 2 |
| 8. | Transportation Engineering Lab -I | TEN 612040 | 0 | 0 | 2 | 1 |
| 9. | Seminar I | TEN 612050 | 0 | 0 | 1 | 1 |
| 10. | AU I (Stress Management by Yoga) | AUD616061 | 2 | 0 | 0 | 0 |
| | | Total Credits | | | | 19 |

Second Semester

| Sl. No | Course Title | | Periods Per Week | | | Credit |
|--------|----------------------------------------------------------|---------------|------------------|----------|----------|----------|
| | | | L | T | P | |
| 1. | Pavement Analysis and Design | TEN 621010 | 3 | 0 | 0 | 3 |
| 2. | Traffic Engineering | TEN 621020 | 3 | 0 | 0 | 3 |
| 3. | Elective – IV | | 3 | 0 | 0 | 3 |
| | Ground Improvement Techniques | TEN 626010 | 3 | 0 | 0 | 3 |
| | Subsurface Investigation and Instrumentation | TEN 626020 | 3 | 0 | 0 | 3 |
| | Road Safety | TEN 626030 | 3 | 0 | 0 | 3 |
| | Operations Research | TEN 626040 | 3 | 0 | 0 | 3 |
| 4. | Elective – V | | 3 | 0 | 0 | 3 |
| | Intersection Design and Analysis | TEN 626050 | 3 | 0 | 0 | 3 |
| | Transportation Economics | TEN 626060 | 3 | 0 | 0 | 3 |
| | Highway Construction Practice | TEN 626070 | 3 | 0 | 0 | 3 |
| | Hill Road Planning, Design, Construction and Maintenance | TEN 626080 | 3 | 0 | 0 | 3 |
| 5. | Elective – VI | | 3 | 0 | 0 | 3 |
| | Transport and Environment | TEN 626090 | 3 | 0 | 0 | 3 |
| | Airport Systems Planning and Design | TEN 626100 | 3 | 0 | 0 | 3 |
| | Mass Transit System | TEN 626110 | 3 | 0 | 0 | 3 |
| | Reinforced Soil Structures | TEN 626120 | 3 | 0 | 0 | 3 |
| 6. | Transportation Engineering Lab - II | TEN 622030 | 0 | 0 | 2 | 1 |
| 7. | Mini Project | TEN 624040 | 0 | 0 | 4 | 2 |
| 8. | AU II (Disaster Management) | AUD626051 | 2 | 0 | 0 | 0 |
| | | Total Credits | | | | 18 |

Third Semester

| Sl. No | Course Title | | Periods Per Week | | | Credit |
|--------|----------------|---------------|------------------|---|----|--------|
| | | | L | T | P | |
| 1. | Dissertation-I | TEN 714010 | 0 | 0 | 32 | 16 |
| | | Total Credits | | | | 16 |

Fourth Semester

| Sl. No | Course Title | Course code | Periods Per Week | | | Credit |
|--------|--------------------------------------------------|-------------|------------------|---|----|--------|
| | | | L | T | P | |
| 1 | Dissertation-II (continued from III semester) | TEN 724010 | 0 | 0 | 32 | 16 |
| | | Total | - | - | - | 16 |

Summary

| Semester | I | II | III | IV |
|------------------------------------|-----------|-----------|-----------|-----------|
| Semester-wise Total Credits | 19 | 18 | 16 | 16 |
| Total Credits | 69 | | | |

Syllabus

First Semester

| | | |
|--------------------------|----------|---------------------------------|
| Course Code | : | TEN611010 |
| Course Title | : | Pavement Materials |
| Number of Credits | : | 3 (L: 3,T: 0, P: 0) |
| Course Category | : | Professional Core Course |

Course Objective:

The objective of this course is to expose students with different pavement materials and their engineering aspects required for pavement construction along with knowledge of bituminous mix design.

Course Content:

| Unit | Content | Hours |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Introduction; Soil as material for embankment and subgrade, classification, properties, laboratory and field test. | 10 |
| II | Road making aggregates:classification, properties of aggregates, aggregate gradationtests on Road aggregates, | 12 |
| III | Bituminous road binders: viscosity grade, emulsions, cut backs and modified binders; rheology of bituminous binders, modified binders; resilient modulus of pavement materials; | 15 |
| IV | Mix design –Marshall method and Superpave procedure; Design of pavement quality concrete mixes, utilization of waste materials in pavements. | 8 |

Recommended Books/References

1. G. Correia, Flexible Pavements, A. A. Balkema Publishers, 1996.
2. P. H. Wright, Highway Engineering, John Wiley & Sons, 1996.
3. S. K. Khanna, C. E. G. Justo and A. Veeraragavan, Highway Material and Pavement Testing, New Chand & Brothers., 2013.
4. G. N. Durhan, W. A. Marr, and W. L. De Groff, Resilient Modulus Testing for Pavement Components, ASTM International, U.S.A., 2003.
5. S. E. Zoorob, A. C. Collop and S. F. Brown, Performance of Bituminous and Hydraulic Materials in Pavements, A. A. Balkema Publishers, 2002.
6. R. N. Hunter, Bituminous Mixtures in Road Construction, Thomas Telford Services Ltd., 1995.
7. ASTM, Annual Book of ASTM Standards – Section IV, Vol. 04.03, ASTM International, 2002.
8. D. Croney, and P. Croney, Design and Performance of Road Pavements, McGraw-Hill, 1998.

Course Outcomes:

After completion of this course students will learn:

- To assess the essential materials required for construction of any pavement.
- The essential engineering properties which must be satisfied by any pavement material to be used for pavement construction.
- Different experiments to be conducted for checking the engineering properties of pavement materials.
- The bitumen mix design for construction of road pavement.

| | | |
|--------------------------|----------|----------------------------------------|
| Course Code | : | TEN 611020 |
| Course Title | : | Urban Transport System Planning |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Core Course |

Course Objective:

Develop a comprehensive understanding of the role and significance of urban transportation systems in shaping cities and influencing socio-economic development. Explore urban transportation policy frameworks and methodologies for transportation planning, considering factors like land use, demand management, and environmental sustainability.

Course Content:

| Unit | Content | Hours |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Fundamentals of transportation planning. Components of transportation system and their interaction. | 10 |
| II | Land use transportation interaction, transportation economics, Historical development and current status of techniques used in travel demand forecasting; Economic theory of travel demand forecasting. | 15 |
| III | Trip generation, trip distribution, mode choice, traffic assignment, Transport system models, Transportation impact study, Data Collection, Passenger and freight movement in urban and regional contexts | 15 |
| IV | public transportation, transportation system management (TSM), evaluation of transportation improvement | 5 |

Recommended Books/References

1. J. D. Ortuzar and L.G. Willumsen, Modelling Transport, John Wiley and Sons, 2001.
2. C.J. Khisty and B.K. Lall, Transportation Engineering – An Introduction, Prentice Hall of India Pvt. Ltd., 2002.
3. C. S. Papacostas and P. D. Prevedouros, Transportation Engineering and Planning, Prentice Hall of India Pvt. Ltd., 2001.
4. P. Chakroborty and A. Das, Principles of Transportation Engineering, Prentice Hall of India Pvt. Ltd., 2003.
5. B.G. Hutchinson, Principles of Urban Transport Systems Planning, McGraw- Hill Book Co., New York, 1974.

6. L.R. Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2000.
7. G. E. Gray and L. A. Hoel, Public Transportation, Prentice Hall, New Jersey, 1992.

Course Outcomes:

The students will learn:

- Grasp the fundamentals of urban transportation networks, modes, and their interactions.
- Learn about the components of urban transport systems, including roads, public transit, non-motorized transport, and more.
- Explore urban planning methodologies and their application to transportation design.
- Understand how land use patterns influence transportation demand and system efficiency.

| | | |
|--------------------------|----------|----------------------------------------------------|
| Course Code | : | TEN 616010 |
| Course Title | : | Geometric Design of Transportation Facility |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

Study of Geometric Design of Transportation Facility provides opportunities for understanding the transportation problems and identification of the needs.

Course Content:

| Unit | Content | Hours |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Geometric design provisions for various transportation facilities as per AASHTO, IRC and other guidelines; discussion of controls governing geometric design, route layout and selection, elements of design | 10 |
| II | sight distances, horizontal alignment, transition curves, super elevation and side friction; vertical alignment: - grades, crest and sag curves | 15 |
| III | highway cross-sectional elements and their design for rural highways, urban streets and hill roads; at-grade inter-sections – sight distance consideration and principles of design, channelization, mini round-abouts, layout of round-abouts | 15 |
| IV | Inter-changes: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design; parking layout and design. | 5 |

Recommended Books/References

1. M. Rogers, Highway Engineering, Blackwell Publishing, 2003.
2. P. H. Wright, Highway Engineering, John Wiley & Sons, 1996.
3. C. H. Oglesby and R. G. Hicks, Highway Engineering, John Wiley & Sons, 1982.
4. R. L. Brockenbrough and K. J. Boedecker, Highway Engineering, McGraw-Hill, 1996.

Course Outcomes:

The students will learn:

- The importance of geometric design in creating safe and efficient transportation facilities.
- About the various elements and factors that influence geometric design decisions.
- About study design controls and guidelines established by transportation authorities to ensure safe and consistent designs.
- The role of design speed, sight distance, and other parameters in geometric design.

| | | |
|--------------------------|----------|-------------------------------------|
| Course Code | : | TEN 616020 |
| Course Title | : | Airport Engineering |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

This course introduces the issues related to Airport planning along with the designing of Runway. The visual aids required from Airport Traffic operating are dealt with. The necessary inputs required for efficiency drainage system has significance in maintenance of airport.

Course Content:

| Unit | Content | Hours |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | General- Regional Planning- Development of New Airport- Data Required before Site Selection- Airport Site Selection- Surveys for Site Selection- Drawings to be prepared- Estimation of Future Air Traffic Needs. | 10 |
| II | Runway Orientation- Basic Runway Length- Corrections for Elevation, Temperature and Gradient- Airport Classification- Runway Geometric Design- Airport Capacity- Runway Configurations- Runway Intersection Design. | 10 |
| III | Introduction- Various Design Factors- Design Methods for Flexible Pavement- Design Methods for Rigid Pavement- LCN System of Pavement Design- Joints in Cement Concrete Pavement- Airport Pavement Overlays- Design of an Overlay. | 15 |
| IV | Airport Grading and Drainage: General- Computation of Earthwork- Airport Drainage- Special Characteristics and Requirements of Airport Drainage- Design Data- Surface Drainage Design Subsurface Drainage Design. | 10 |

Recommended Books/References

1. S.K. Khanna, M.G. Arora, Airport Planning and Designing, Nemchand publisher, 1969.
2. L. R. Kadyali and Dr. N. B. Lal, Principles and Practices of Highway Engineering (Including Expressways and Airport Engineering), Khanna Publisher, 2023.
3. S. K. Sharma, Principles, Practice and Design of Highway Engineering, S Chand Publishing, 2017.

4. S. P. Chandola, A Textbook of Transportation Engineering, S Chand Publishing, 2008.

Course Outcomes:

The students will be able to:

- Plan the region for an airport.
- Design the runway length after considering the correction required for basis runway length.
- Understand the visual aids required for safe landing and takeoff operating of airport.
- Analysis and Design the drainage.

| | | |
|--------------------------|----------|--------------------------------------|
| Course Code | : | TEN 616030 |
| Course Title | : | Intelligent Transport Systems |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

Its aims to streamline the operation of vehicles that manages vehicle traffic, assists drivers with safety and other information, along with provisioning of convenience applications for passengers and road safety.

Course Content:

| Unit | Content | Hours |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Introduction to Intelligent Transportation Systems (ITS) – 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) | 10 |
| II | Geographic Information Systems (GIS), video data collection. Telecommunications in ITS – Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Road side communication – Vehicle Positioning System, ITS functional areas – Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO) | 15 |
| III | 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. | 15 |
| IV | 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, smart vehicles using internet of things (IOT), infrastructures design for e-vehicles and their charging points. | 5 |

Recommended Books/References

1. Kan Paul Chen, John Miles, ITS Hand Book: Recommendations for World Road Association (PIARC),2000
2. J. M. Sussman, Perspective on ITS Artech House Publishers, 2005.
3. National ITS Architecture Documentation, US Department of Transportation, 2007 (CD-ROM).

Course Outcomes:

The students will learn:

- The concept and significance of Intelligent Transport Systems.
- How ITS technologies and solutions contribute to improving transportation efficiency and safety.
- To explore various components of ITS, such as sensors, communication systems, data processing, and control centers.
- The role of predictive analytics in optimizing traffic flow and reducing congestion.

| | | |
|--------------------------|----------|------------------------------------------------------|
| Course Code | : | TEN 616040 |
| Course Title | : | GIS application in Transportation Engineering |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

Familiarize students with the fundamental concepts, principles, and components of Geographic Information Systems. Develop a strong foundation in transportation engineering principles, including traffic flow, transportation modes, and infrastructure components, techniques for acquiring, managing, and processing spatial data relevant to transportation networks, such as road networks, traffic counts, and transportation-related attributes.

Course Content:

| Unit | Content | Hours |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Definition, Components of Remote Sensing, Energy, Sensor, Interacting Body, Active and Passive Remote Sensing, Platforms, Aerial and Space Platforms, Balloons, Helicopters, Aircraft and Satellites, Electromagnetic Radiation, EMR Spectrum. | 10 |
| II | Basic Concept and Components, Hardware, Software, Data Spatial and non-spatial, Geo-referencing, Map Projection, Types of Projection, Simple Analysis, Data retrieval and querying Database, Raster and Vector data structures, Data storage, run length, Chain and Block coding, Vector data storage, Topology | 15 |
| III | GIS Modeling - Raster and Vector data analysis– Buffering and overlaying techniques – Network Analysis – Spatial Analysis. Highway and Railway Alignment, location of transport Terminals and roadside facilities, bus stops – Route optimization – Bus route rationalization – Accident analysis – Applications of Aerial Photography and Satellite Imageries. | 15 |

| | | |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| IV | GIS as an integration technology – Integration of GIS, GPS and Remote Sensing Techniques – Advanced Traveller Information System (ATIS) – Automatic Vehicle Location System (AVLS).LIDAR and Drone based surveys. | 5 |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|

Recommended Books/References

1. Anji Reddy, Remote Sensing and Image Interpretation, John Wiley and Sons Inc. New York, 1987.
2. M. G. Srinivas, Remote Sensing Applications, Narosa Publishing House, 2001
3. P. A. Burrough, Principles of GIS for Land Resources Assessment, Oxford Publication, 1994.
4. Jeffrey Star and John Ester, Geographical Information System – An Introduction, Prentice Hall Inc.,EnglewoodCliffe, 1990.
5. D. F. Marble, H. W. Calkins and Penquest, Basic Readings in GIS, Speed System Ltd., New York, 1984.
6. S. K. Ghosh and A. M Chandra, Remote Sensing and GIS, Narosa Publications House.
7. Thill Jean-Claude, Geographical Information Systems in Transportation Research, Pergamon, 2000.
8. O’ Sullivan David, Geographic Information Analysis, John Wiley & Sons, 2003.
9. P. A. Longley, M. J. Barnsley, Jean-Paul Donnay, Remote Sensing and Urban Analysis, Taylor & Francis, 2001.

Course Outcomes:

The students will learn to:

- Understand the basic principles of Geographic Information Systems (GIS), including spatial data representation, coordinate systems, and map projections.
- Learn how to analyze transportation networks, including roadways, highways, and public transit systems, using GIS tools.
- Acquire skills in collecting, processing, and managing spatial data related to transportation infrastructure, traffic volumes, and travel patterns.
- Explore various spatial analysis techniques to identify traffic congestion, assess accessibility, and analyze transportation demand.

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|--------------------------|----------|-------------------------------------|
| Course Code | : | TEN 616050 |
| Course Title | : | Pavement Geotechniques |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The objectives of this course are to learn the student about the different engineering properties, behaviour of the soil which is used for pavement application.

Course Content:

| Unit | Content | Hours |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Introduction; Compaction behavior of soil, effect of compaction, laboratory and field compaction. | 6 |
| II | Stress-strain behavior of soils; Mohr Circle of Stress; Principal Stresses. Shear strength of soil; drained and undrained shear strength of soils, Significance of pore pressure parameters; Determination of shear strength; Interpretation of triaxial test results. | 13 |
| III | Stress path; Drained and undrained stress path; Stress path with respect to different initial state of the soil; Stress path for different practical situations. | 13 |
| IV | Critical state soil mechanics; Critical state parameters; Critical state for normally consolidated and over consolidated soil; Behavior of sands; Critical void ratio; Effect of dilation in sands; introduction to yielding and hardening; | 13 |

Recommended Books/References

1. J. H. Atkinson and P.L Bransby, The Mechanics of Soils: An introduction to critical soil mechanics, McGraw Hill, 1978.
2. J. H Atkinson, An introduction to the Mechanics of soils and Foundation, McGraw-Hill Co., 1993.
3. B. M. Das, Advanced Soil Mechanics, Taylor and Francis, 2nd Edition, 1997.
4. D. M. Wood, Soil Behavior and Critical State Soil Mechanics, Cambridge University Press, 1990.
5. R. F. Craig, Soil Mechanics, Van Nostrand Reinhold Co. Ltd., 1987.
6. K. Terzaghi and R.B. Peck, Soil Mechanics in Engineering Practice, John Wiley & Sons, 1967.
7. T. W. Lambe and R. V. Whitman, Soil Mechanics, John Wiley & Sons, 1979.

Course Outcomes:

The students will be able to:

- Find out the compaction and strength aspect of soil to be used for pavement.
- Analyze the laboratory results of soil to be used for pavement.
- Predict the stress path of soil under various field conditions.
- Able to know about the critical state behavior of soil.

| | | |
|--------------------------|----------|------------------------------------------------------------|
| Course Code | : | TEN 616060 |
| Course Title | : | Pavement Evaluation, Rehabilitation and Maintenance |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

To understand the process of pavement maintenance and rehabilitation techniques in logical sequence involving existing pavement structural evaluation and condition assessment, distress mechanisms, assignment of feasible alternatives and overall design.

Course Content:

| Unit | Content | Hours |
|------|--------------------------------------------------------------------------------------------------------------|-------|
| I | Introduction and definitions. Types of pavement distress. | 7 |
| II | Techniques for functional and structural evaluation of pavements, network and project survey and evaluation, | 15 |
| III | Pavement rehabilitation techniques, overlay design procedures, recycling of flexible and rigid pavements, | 15 |
| IV | Maintenance of paved and unpaved roads, pavement management systems. | 8 |

Recommended Books/References

1. R. Robinson, and B. Thagesan, Road Engineering & Development, Spon Press, 2004.
2. Yang H. Huang, Pavement Analysis and Design, Pearson Prentice Hall, 2004.
3. Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.
4. K. Atkinson, Highway Maintenance Handbook, Thomas Telford, 1997.
5. C. A. O' Flaherty, Highways – The Location, Design, Construction, & Maintenance of Pavements, Butterworth Heinemann, 2002.
6. National Highway Institute, Pavement Maintenance and Rehabilitation, Federal Highway Administration Report NHI-97-024, July 1998.
7. R. Haas, W. R. Hudson and J. P. Zaniewski, Modern Pavement Management, Krieger Publishing Company. Malabar, Florida, 1994.

Course Outcomes:

The students will learn to:

- Classify fundamental types of distresses and their mechanisms in flexible and rigid pavements
- Define steps in condition surveys and data collection procedures for pavement maintenance and rehabilitation.
- Identify feasible maintenance and rehabilitation methods for flexible and rigid pavements
- Prepare design project based on feasible alternatives of maintenance and rehabilitation for flexible pavements.

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|--------------------------|----------|-------------------------------------|
| Course Code | : | TEN 616070 |
| Course Title | : | Project Management |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The objective of this course is to learn students about the different management skills for any civil engineering project, their implementation, quality, related economy and related different ideas.

Course Content:

| Unit | Content | Hours |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Concepts of material management. Concepts of manpower management. Project management, relationships among portfolio management, program management, project management, and organizational project management, relationship between project management, operations management and organizational strategy, business value, role of the project manager, project management body of knowledge. | 7 |
| II | Generation and Screening of Project Ideas: Generation of ideas, monitoring the environment, corporate appraisal, scouting for project ideas, preliminary screening, project rating index, sources of positive net present value. | 7 |
| III | Project costing, Project Scope Management: Project scope management, collect requirements define scope, create WBS, validate scope, control scope. Organizational influences & Project life cycle: Organizational influences on project management, project state holders & governance, project team, project life cycle. Project Integration Management: Develop project charter, develop project management plan, direct & manage project work, monitor & control project work, perform integrated change control, close project or phase. | 15 |
| IV | Project Quality management: Plan quality management, perform quality assurance, and control quality. Project Risk Management: Plan risk management, identify risks, perform qualitative risk analysis, perform quantitative risk analysis, plan risk resources, control risk. Project Cost Management: Plan cost management, estimate cost, determine budget, cost control. Network Techniques for Project Management: Development of project network, time estimation, determination of the critical path, PERT Model, CPM model, numerical problems. Scheduling when resources are limited. | 16 |

Recommended Books/References

1. Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Edition, 2013, ISBN: 978-1-935589-67-9.
2. Harold Kerzner, Project Management: A System approach to Planning Scheduling & Controlling, John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
3. P. Chandra, Project Planning Analysis Selection Financing Implementation & Review, Tata McGraw Hill Publication, 7th Edition, 2010, ISBN 0-07-007793-2.

4. R. Burke, Project Management – Planning and Controlling Techniques, John Wiley & Sons, 4th Edition, 2004, ISBN: 9812-53-121-1

Course Outcomes:

The students will learn:

- About the various management skill of a civil engineering project.
- About the development of project ideas and their management plan.
- Role of different stakeholders for the smooth functioning of any project.
- The quality and risk management of project.

| | | |
|--------------------------|----------|---------------------------------------------------|
| Course Code | : | TEN 616080 |
| Course Title | : | Climate Change and Sustainable Development |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The objective of this course is to provide knowledge about climate change, its impact on environment, transportation, clean technology which is going to reduce the impact of climate change.

Course Content:

| Unit | Content | Hours |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | The Earth's Climate Machine, Climate Classification, Global Wind Systems, Trade Winds and the Hadley Cell, The Westerlies, Cloud Formation, Indian Monsoon, Storms and Hurricanes, Hydrological Cycle, Global Ocean Circulation, El Nino and its Effect, Solar Radiation, Earth's Natural Green House Effect, Green House Gases and Global Warming, Carbon Cycle. | 10 |
| II | Changes in patterns of temperature, precipitation and sea level rise, Observed effects of Climate Changes: Patterns of Large Scale Variability, Drivers of Climate Change, Climate Sensitivity and Feedbacks – The Montreal Protocol – UNFCCC – IPCC, Evidences of Changes in Climate and Environment, on a Global Scale and in India, climate change modeling. | 15 |
| III | Climate Impacts on transportation: Impacts on Land-Based Transportation, Impacts on Air Transportation, Impacts on Marine Transportation, Impacts on River Transportation, Key Mitigation Technologies and Practices: Carbon sequestration, | 10 |
| IV | Clean Technology and Energy: Clean Development Mechanism –Carbon Trading- examples of future Clean Technology – Biodiesel – Natural Compost – Eco- Friendly Plastic – Alternate Energy – Hydrogen – Bio- | 10 |

| | | |
|--|---------------------------------------------------------------------------------------------------------|--|
| | fuels – Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding. | |
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Recommended Books/References

1. Anil Markandya, Climate Change and Sustainable Development: Prospects for Developing Countries, Routledge, 2002.
2. G. M. Heal, Interpreting Sustainability, in Sustainability: Dynamics and Uncertainty, Kluwer Academic Publ., 1998.
3. C. J. Jepma and M. Munasinghe, Climate Change Policy – Facts, Issues and Analysis, Cambridge University Press, 1998.
4. M. Munasinghe, Sustainable Energy Development: Issues and Policy in Energy, Environment and Economy: Asian Perspective, Kleindorfer P. R. et. al (ed.), Edward Elgar, 1996.
5. S. K. Dash, Climate Change – An Indian Perspective, Cambridge University Press India Pvt. Ltd, 2007.

Course Outcomes:

The students will be able to:

- Know about the climate and its different components.
- Know about the factors which are responsible for climate change.
- Know about the impact of transportation system on climate change and its mitigation methods.
- Know about clean technology for energy production which is going to help in reducing the impact of transportation effect and other effect on climate change.

| | | |
|--------------------------|---|----------------------------------------|
| Course Code | : | TEN 616090 |
| Course Title | : | Environmental Impact Assessment |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The course aims to introduce the concepts, procedures and methodology of Environmental Impact Assessment (EIA), to develop a critical awareness of factors which affect the use of EIA as part of project management in the legislative and regulatory context of recently-industrialized or less - industrialized countries, and to expose the students to the need for environmental impact assessments and how to prepare the various documents required by State and Central Government Regulations.

Course Content:

| Unit | Content | Hours |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Introduction of environmental impact assessment: Definition of Environmental Impact Assessment, Need for environmental impact assessment (EIA); Requirements and levels of EIA. EIA and Sustainable | 15 |

| | | |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| | Development. | |
| II | Environmental Impact Assessment Process: Environmental Assessments, Environmental Impact Statement, Basic Steps in the Process: Alternative, Screening, Scoping, Impact analysis, Mitigation, Follow up, Public Participation and EIA. | 15 |
| III | Impact prediction methodologies and mitigation measures: Air, Surface and ground water, Noise, Cultural and socioeconomic. EIA Monitoring and Auditing, Environmental Clearance: Guidelines, acts and legislations, codes and country practices. | 15 |

Recommended Books/References

1. John Glasson, Riki Therivel and Andrew Chadwi, Introduction to Environmental Impact Assessment - Principles and procedures, process, practice and prospects, UCL Press, 3rd Edition, 2005.
2. Peter Morris and Riki Therivel, Methods of Environmental Impact Assessment, Routledge, 3rd Edition, 2009.
3. Barbara Carroll and Trevor Turpin, Environmental Impact assessment handbook - A practical guide for planners, developers and communities, Thomas Telford, 2nd Edition, 2009.
4. Judith Petts, Handbook of Environmental Impact Assessment - Vol 1 (Environmental Impact Assessment: Process, Methods and Potential, Wiley, 2005.
5. P. Wathern, Environmental Impact Assessment: Theory and Practice, Routledge Publishers, 1990.
6. B. Marriott, Environmental Impact Assessment: A Practical Guide, McGraw-Hill Publication, 1997.
7. A. K. Shrivastava, Nicola Baxter, Jacob Grimm, Environmental Impact Assessment, APH Publishers, 2003.
8. Y. Anjaneyulu, Valli Manickam, Environmental Impact Assessment Methodologies, CRC Press, 2011
9. J. Glasson, Riki Therivel, Andrew Chadwick, Introduction to Environmental Impact Assessment, Oxford Brookes University, 2012.

Course Outcomes:

On successful completion of this course students will be able to:

- Connect perspectives from ecological and social sciences to understand complex socio-ecological issues in developmental projects at multiple spatial scales
- Analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence during Project Scoping for EIA
- Communicate research findings effectively through written, media materials and colloquia in Public hearing for project based EIA
- Assess social and environmental impacts of different policies, plans, and programs (PPP) for strategic environmental assessment (SEA)

| | |
|--------------------------|---------------------------------------------|
| Course Code | : TEN616100 |
| Course Title | : Finite Element Method and Analysis |
| Number of Credits | : 3 (L: 3, T: 0, P: 0) |
| Course Category | : Professional Elective Course |

Course Objective:

The course intends to present numerical techniques for solving governing equations in mechanical systems. It encompasses a range of challenges, including 1D and 2D structural, thermal, and fluid problems. Additionally, it covers beams and frames issues. The curriculum also introduces concepts related to non-linear and dynamic problems.

Course Content:

| Unit | Content | Hours |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | The basic concepts in FEM: - Introduction: Finite difference method (FDM), finite element method (FEM), advantages of FEM over FDM, One-dimensional problems, Axial deformations of a bar, Strong and weak forms, Essential vs. natural boundary conditions, Variational formulations (Principle of virtual work, principle of minimum potential energy), Approximations (Rayleigh-Ritz & Galerkin). Weighted Residual Methods: Collocation, sub-domain, Galerkin's and least square, Finite element basis functions (linear and quadratic elements), Assembly, Problems with smooth and non-smooth solutions, Convergence. | 10 |
| II | Bars, Trusses and Beams: Relevance of finite element analysis in design, Modelling and discretization, Shape functions, elements and Degrees-of-Freedom, Strain-displacement relation, Local and Global equations, Applications of FEA. ISO-Sub-Super parametric formulations. 1D Elements Structural Problems: Linear and Quadratic elements, Elimination and Penalty Approach, Properties of global stiffness matrix. Formulation of Truss element, Plane truss. Beam: Element formulation, plane frames, various loading and boundary conditions. | 15 |
| III | Two-Dimensional Problems: Two-Dimensional Problems of elasticity, Plain stress problem, plain strain problem, Stiffness matrix for constant strain triangle, equivalent nodal force vector, linear strain triangle, four noded rectangular element. | 10 |
| IV | Shape function: Shape function for one-dimensional element-cartesian coordinates, natural coordinates, Shape function for two-dimensional element-rectangular and triangular element, elements in three dimension – rectangular prism, tetrahedral elements. | 10 |

Recommended Books/References

1. E. B. Becker, G. F. Carey and J. T. Oden, Finite Elements: An Introduction, Volume I, Prentice Hall, 1981.
2. R D Cook, D S Malkus, M E Plesha, and R J Witt, Concepts and Applications of Finite Element Analysis, Wiley.
3. P. Seshu, Text book of Finite Element Analysis, PHI.
4. K. J. Bathe, Finite Element Procedures, PHI.
5. T. R. Chandrupatla and A. D. Belegunda. Introduction to Finite Elements in Engineering, PHI.

6. P. N. Godbole, Introduction to finite Element Method, I. K. International Publishing House Pvt. Ltd., 2013.

Course Outcomes:

After completion of this course:

- Students will be able to understand the concept of finite element method and develop algorithms for analysis of mechanical systems.
- Students will be able to apply the knowledge of FEM for 1D stress analysis, modal analysis, heat transfer analysis and flow analysis.
- Students will be able to formulate and solve problems of trusses, beams and frames, students will also be able to use commercial packages for complex problems

| | | |
|--------------------------|----------|--------------------------------------------------|
| Course Code | : | TEN 616110 |
| Course Title | : | Design and Maintenance of Low Volume Road |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The objective of this course is to provide knowledge to students about rural road, its different component, and its design and maintenance aspect.

Course Content:

| Unit | Content | Hours |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Introduction: Importance of Rural roads, Classification of rural roads, Terrain classification, Socio-economic impact of rural roads. Planning and Alignment: Data base for master plan, Concept of network planning, Rural Roads plan, Road alignment, Governing factors for route selection, Factors controlling alignment, Surveys, Detailed project report, Environmental issues. | 12 |
| II | Road Materials: General, Soil and material surveys, Soil as road construction material, Stabilized soils, Aggregates for pavement courses, New materials and stabilizers, Materials for bituminous construction, Materials for semi-rigid and rigid pavement, Materials for special pavements Climatic suitability of concrete materials | 10 |
| III | Pavement Design: Introduction, Design parameters, Pavement components, Design of flexible pavement, Design of semi-rigid pavement, Design of rigid pavement, Design of special pavements, | 10 |
| IV | Drainage and Shoulders Specifications and Construction: General, Selection of construction materials and methodology, Earthwork, Sub-base, Base course, Bituminous constructions, Semi-rigid pavement construction, Concrete pavements, Construction of special pavements, Equipment required for different operations | 13 |

Recommended Books/References

1. S.K. Khanna, C.E.G Justo and A. Veeraragavan Highway Engineering, Nemchand Brothers publications.
2. IRC: SP 20-2002, "Rural Roads Manual".
3. IRC: SP 72-2007, Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads.
4. IRC: SP 62-2004, Guidelines for the Design and Construction of Cement Concrete Pavements for Rural Roads.
5. IRC, Specifications for Rural Roads, MoRD, 2004.
6. CRRI, Various Reports on Use of Waste Materials.

Course Outcomes:

The students will learn:

- About the rural road and its different component.
- About the materials used for construction and maintenance of rural road.
- About the pavement design of rural road.
- About the construction of drainage facilities.

| | | |
|--------------------------|----------|-------------------------------------|
| Course Code | : | TEN 616120 |
| Course Title | : | Railways and Waterways |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

Provide students with a strong foundation in the principles, theories, and concepts related to railways and waterways engineering, enabling them to understand the complexities of transportation systems and infrastructure.

Course Content:

| Unit | Content | Hours |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Historical development of railway tracks, permanent way, rails, rail joints and welding of rails, sleepers, sleeper fastenings, blast and formation, | 10 |
| II | Geometric design of the track, points and crossing, signaling, interlocking, track stresses, traction and tractive resistance. Syncrolift equipment in ports (General definition consideration and aspects in planning and design of ports and terminals) | 15 |
| III | physical planning, location and orientation of major port components, access channels, basins, breakwaters, wharfs, quays piers, jetties, fenders, simulation modeling, analytical solutions | 15 |
| IV | Cargo handling systems, economic feasibility and evaluation. Mass Rapid Transport System. | 5 |

Recommended Books/References

1. S.C. Saxena and S. P. Arora, A Text Book of Railway Engineering, Dhanpat Rai Publication, 1981.
2. M. M. Agarwal and Satish Chandra, Railway Engineering Oxford University Press, 2013.
3. Aegerschou et. al., Planning and Design of Port and Marine Terminals, Thomas Telford Publishing, 2004.
4. British Ports Association, Institution of Civil Engineers (Great Britain), Port Engineering and Operations: Proc. Conference of British Ports and Future, New Castle upon Tynes, Thomas Telford, London, 1985.
5. Hennes and Eske, Fundamentals of Transportation Engineering, McGraw-Hill Book Co., 1969.
6. G.P. Tsinker, Port Engineering Planning Construction Maintenance and Security, John Welly and Sons, 2004.

Course Outcomes: The students will learn about:

- Railway track design and alignment principles.
- Signaling and control systems for safe train operations.
- Rolling stock technology, including locomotives and railcars.
- Maintenance strategies to ensure track safety and efficiency.
- Railway electrification and power supply systems.

| | | |
|--------------------------|---|-------------------------------------|
| Course Code | : | TEN 611030 |
| Course Title | : | Research Methodology and IPR |
| Number of Credits | : | 2 (L: 2, T: 0, P: 0) |
| Course Category | : | Professional Core Course |

Course Objective:

To impart knowledge on formulation of research problem, research methodology, and ethics involved in doing research and importance of IPR protection

Course Content:

| Unit | Content | Hours |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Problem Identification & Formulation: Research Question, Investigation Question, Measurement Issues, Hypothesis: Qualities of a good Hypothesis, Null Hypothesis & Alternative, Hypothesis Testing – Logic & Importance. | 10 |
| II | Research Design: Features of a good research design, Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. Qualitative and Quantitative Research: Qualitative research, Quantitative research, Model evaluation guidelines. | 10 |
| V | Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Water Resources/Transportation Engineering, Impact factor of Journals, Ethical issues related to publishing, Plagiarism and Self-Plagiarism, Reference Management Software like Mendeley. | 5 |

| | | |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| VI | Understanding basics of IPR, Types of patent application and claim construction, Patent search, Procedure and managements of patents, Assessment of new idea, its patentability and patent filing procedure | 5 |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|

Recommended Books/References

1. D. C. Montgomery, Design and Analysis of Experiments, Willey, India, 2007.
2. C. R. Kothari, Research Methodology- Methods and Technique, New Age International, New Delhi, 2004
3. D. C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, Willey, India, 2007
4. Stuart Melville and Wayne Goddard, Research Methodology: An introduction for Science & Engineering Students, Juta and Co. Limited, 1996
5. R. Kumar, Research Methodology: A Step by Step Guide for Beginners, Pearson India, 2nd Edition, 2005.
6. D. J. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd, 2007.

Course Outcomes:

At the end of this course, students will be able to

- Understand research problem formulation & Analyze research related information and Follow research ethics
- Correlate the results of any research article with other published results. Write a review article in the field of engineering.
- Appreciate the importance of IPR and protect their intellectual property. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits

| | | |
|--------------------------|----------|-------------------------------------------------|
| Course Code | : | TEN 612040 |
| CourseTitle | : | Transportation Engineering Laboratory -I |
| Number of Credits | : | 1 (L:0,T:0, P:2) |
| Course Category | : | Laboratory Course |

Course Objective:

Transportation Engineering Laboratory fulfils the needs of analyzing the traffic movements and testing the pavement materials. In this section 1, the test of pavement material is to be done.

Course Content:

| Experiment Number | Name of Test |
|--------------------------|------------------------------------------------------------------------------------------|
| 1 | To determine the aggregate crushing value of coarse aggregate (IS 2386 – Part IV -1963) |
| 2 | To determine the impact value of coarse aggregate (IS 2386-Part IV-1963) |
| 3 | To determine the los angeles abrasion value of coarse aggregate (IS 2386 –Part IV -1963) |
| 4 | To determine the penetration value of bitumen material (IS 1203-1978) |

| | |
|----------|-------------------------------------------------------------------------|
| 5 | To determine softening point of bituminous material (IS 1205-1978) |
| 6 | To determine the ductility value of bituminous material (IS 1208-1978). |

Recommended Books/References

1. Indian Standard –Methods of test for aggregates for concrete –Part IV Mechanical Properties (IS:2386 –Part IV-1963)
2. Indian Standard – Methods for testing tar and bituminous materials (IS: 1201-1978 to IS: 1220 -1978)

Course Outcome:

In this lab, the properties of coarse aggregate is to be found and properties of bituminous material is to be found so that it will be easy to learn that what type of material is required for construction of road pavement.

| | | |
|--------------------------|----------|---------------------------------|
| Course Code | : | TEN 612050 |
| Course Title | : | Seminar I |
| Number of Credits | : | 1 (L:0,T:0, P:2) |
| Course Category | : | Professional Core Course |

Course Objective:

1. Identify and compare technical and practical issues related to the area of WRE/TE.
2. Prepare a well-organized report employing elements of technical writing and critical thinking.
3. Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

Course Outcome:

- Establish motivation for any topic of interest and develop a thought process for technical presentation.
- Organize a detailed literature survey and build a document with respect to technical publications.
- Analysis and comprehension of proof-of-concept and related data.
- Effective presentation and improve soft skills.

| | | |
|--------------------------|----------|------------------------------------------|
| Course Code | : | AUD616061 |
| Course Title | : | AUD I (Stress Management by Yoga) |
| Number of Credits | : | 0 (L: 2, T: 0, P: 0) |
| Course Category | : | Audit Course |

Course Objective:

The main aim of this course is to teach students about stresses, their effects and different yoga/meditation techniques for relieving the stress of the body and mind.

Course Content:

| Unit | Content | Hours |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1 | Meaning and Definition of Stress. Types: Eutress, Distress, Anticipatory Anxiety, Intense Anxiety and Depression. Meaning of Management – Stress Management. | 6 |
| 2 | Concept of Stress according to Yoga: Patanjali aphorism (PYS II - 3) Avidya Asmita. Bhagavad – Gita (Gita II 62-63) Dhayato Visayam Punsah, Yoga Vasistha and Upanishad. | 8 |
| 3 | Mechanism of Stress related diseases: Psychic, Psychosomatic, Somatic and Organic phase. Role of Meditation & Pranayama on stress – physiological aspect of Meditation. Constant stress & strain, anxiety, conflicts resulting in fatigue among Executive. Contribution of Yoga to solve the stress related problems of Executive. | 8 |
| 4 | Meaning and definition of Health – various dimensions of health (Physical, Mental, Social and Spiritual) – Yoga and health – Yoga as therapy. Physical fitness. Stress control exercise – Sitting meditation, Walking meditation, Progressive muscular relaxation, Gentle stretches and Massage. | 8 |

Recommended Books/References

1. Andrews, Linda Wasmer., Stress Control for peace of Mind. London: Greenwich Editions, 2005.
2. Lalvani, Vimla., Yoga for stress. London: Hamlyn, 1998.
3. H.R. Nagendra, and R. Nagarathana, Yoga perspective in stress management. Bangalore: Swami Vivekananda Yoga Prakashana, 2004
4. H.R. Nagendra and R. Nagarathana, Yoga practices for anxiety & depression. Bangalore: Swami Sukhabodhanandha Yoga Prakashana, 2004.
5. S., Swami, Stress Management. Bangalore: Prasanna trust, 2002.
6. K.N. Udupa, Stress management by Yoga. NewDelhi: Motilal Banaridass Publishers Private Limited, 1996.

Course Outcome:

After completion of this course, students will be able to

- Know about the different kind of stresses occurs in the individual.
- Know about the diseases occurs due to stresses developed in body and mind.
- Know about different kind of yoga/mediation for reliving the stresses.

Second Semester

| | | |
|--------------------------|---|-------------------------------------|
| Course Code | : | TEN 621010 |
| Course Title | : | Pavement Analysis and Design |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Core Course |

Course Objective:

The objective of this course is to teach students about the analysis of road pavement and teaches them the design of both rigid and flexible pavement as per IRC.

Course Content:

| Unit | Content | Hours |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Types of Pavements: Factors affecting design of pavements, wheel loads, ESWL Concept, tyre pressure, contact pressure, Material characteristics, Environmental and other factors | 10 |
| II | Stresses in flexible pavement: layered systems concept, one-layer system, Business Two-layer system, Burmister Theory for Pavement Design. Stresses in rigid pavements: relative stiffness of slab, modulus of sub-grade reaction, Westergaard's stresses due to warping, stresses due to loads, stresses due to friction. | 15 |
| III | Pavement design: CBR Method of Flexible Pavement Design- IRC method of flexible pavement design, AASHTO Method of Flexible Pavement design, IRC: 58-2002, IRC:58-2015. | 10 |
| IV | IRC method of Rigid pavement design: Importance of Joints in Rigid Pavements, Types of Joints, Use of Tie Bars and Dowell Bars. AASHTO method of Rigid pavement design. | 10 |

Recommended Books/References

1. Y. H. Huang, Pavement Analysis and Design, Pearson Prentice Hall, 2004.
2. Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.
3. Sharma and Sharma, Principles and Practice of Highway Engg., Asia Publishing House, 1980.
4. Teng, Functional Designing of Pavements, McGraw- Hill, 1980.

Course Outcomes:

The students will be able to:

- Explain about pavement material characterization.
- Outline pavement design principles and traffic consideration.
- Discuss about analysis and design of flexible pavement.
- Discuss about analysis and design of concrete pavement.

| | | |
|--------------------------|----------|---------------------------------|
| Course Code | : | TEN 621020 |
| Course Title | : | Traffic Engineering |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Core Course |

Course Objective:

To understand the concepts of highway capacity to be aware of various methods of collecting traffic data to understand the basics of highway planning and design, and workout problems in design of road geometrics to learn the principles of intersection design to learn the importance of road safety

Course Content:

| Unit | Content | Hours |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Driver behaviour, traffic information and control systems, traffic studies-volume, speed and delay studies, elements of traffic flow theory | 10 |
| II | characteristics of uninterrupted traffic, capacity and LOS of Uninterrupted facilities, characteristics of interrupted traffic, traffic characteristics at unsignalised intersections | 15 |
| III | design of signalized intersections, capacity and LOS of signalized intersections, actuated signal control, signal coordination, design of parking, lighting and terminal facilities, | 15 |
| IV | Simulation of traffic systems, statistics and probability in traffic engineering, trends in traffic engineering. | 5 |

Recommended Books/References

1. R. P. Roess, William R. McShane & Elena S. Prassas, Traffic Engineering, Prentice-Hall, 1990.
2. L. J. Pignataro, Traffic Engineering – Theory and Practice, Prentice Hall, 1973.
3. C. J. Khisty and B. K. Lall, Transportation Engineering: An Introduction, Prentice-Hall India, 2003.
4. M. Wohl and B. V. Martin, Traffic System Analysis, McGraw-Hill Book Company, 1967.
5. P. Chakroborty and A. Das, Principles of Transportation Engineering, Prentice Hall of India Pvt. Ltd., 2003.
6. L. R. Kadiyali, Traffic Engineering, Khanna Publishers, 2000.
7. A. D. May, Traffic Flow Fundamentals, Prentice–Hall, 1990.
8. C.S. Papacostas, Transportation Engineering and Planning, Prentice-Hall India, 2001.
9. Highway Capacity Manual (HCM), Transportation Research Board, USA, 2000.
10. Highway Capacity Manual (HCM), Transportation Research Board, USA, 2000.

Course Outcomes:

The students will learn:

- The fundamental concepts and principles of traffic engineering.
- About the importance of traffic engineering in managing transportation systems.

- The basics of traffic flow, including parameters like volume, density, speed, and flow rate.
- To explore the relationships between these parameters and their impact on roadway performance.
- About various techniques for collecting traffic data, such as loop detectors, cameras, and surveys.
- To analyze traffic data to assess congestion, travel patterns, and peak periods.

| | | |
|--------------------------|----------|--------------------------------------|
| Course Code | : | TEN 626010 |
| Course Title | : | Ground Improvement Techniques |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The objective of this course is to provide knowledge about the different methods of ground improvement, their field application, and suitability for different soils and site.

Course Content:

| Unit | Content | Hours |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Site investigation and subsoil exploration; Methods of boring and sampling; Field tests; Engineering properties of soft, weak and compressible deposits | 10 |
| II | Static and Dynamic compaction; Preloading; Vertical drains; Granular piles | 14 |
| III | Lime stabilization and injection; Grouting; Soil nailing; Anchors; Vacuum consolidation; Thermal, electrical and chemical methods | 14 |
| IV | Electro-osmosis; soil freezing; vacuum consolidation, Case histories. | 7 |

Recommended Books/References

1. J.E. Bowles, Foundation Analysis and Design, McGraw-Hill International Edition, 1997.
2. M.R. Hausmann, Engineering Principles of Ground Modification, McGraw-Hill International Editions, 1990.
3. R. Yonekura, M. Terashi and M. Shibazaki (Eds.), Grouting and Deep Mixing, A.A. Balkema, 1966.
4. M.P. Moseley, Ground Improvement, Blackie Academic & Professional, 1993.
5. P.P. Xanthakos, L.W. Abramson and D. A. Bruce, Ground Control and Improvement, John Wiley & Sons, 1994.

Course Outcomes:

The students will be able to:

- Identify the poor site/soil to be used for infrastructure development.
- Choose the specific technique for treatment of poor soil to be used for

construction purpose.

- Treat existing foundation soil so that the safety of structure can be maintained.
- Handle project work related to soil modification.

| | | |
|--------------------------|---|-----------------------------------------------------|
| Course Code | : | TEN 626020 |
| Course Title | : | Subsurface Investigation and Instrumentation |
| Number of Credits | : | 3 (L:3, T:0, P:0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The objective of this course is to make students understand the importance of site investigation, planning of sub soil investigation, and interpretation of investigated data to design suitable foundation system.

Course Content:

| Unit | Content | Hours |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Scope and objectives, planning of exploration program - methods of exploration - exploration for preliminary and detailed design, spacing and depth of bores, data presentation. - Geophysical exploration and interpretation - reflection, refraction and resistivity: Spectral analysis of surface waves (SASW), Multichannel Analysis of Surface Waves (MASW), cross hole – up hole - down hole methods. | 15 |
| II | Methods of boring and drilling, non-displacement and displacement methods, drilling in difficult subsoil conditions, offshore drilling, limitations of various drilling techniques, stabilization of boreholes, bore logs. | 10 |
| III | Sampling Techniques – quality of samples – factors influencing sample quality - disturbed and undisturbed soil sampling advanced sampling techniques, offshore sampling, shallow penetration samplers, preservation and handling of samples. | 12 |
| IV | Instrumentation in soil engineering, functional components of data acquisition system - strain gauges, resistance and inductance type, load cells, earth pressure cells, settlement and heave gauges, pore pressure measurements - slope indicators, sensing units, case studies. | 8 |

Recommended Books/References

1. R.E. Hunt, Geotechnical Engineering Investigation Manual, McGraw Hill, 1984.
2. A. Singh and G. R. Chowdhary, Soil Engineering in Theory and Practice, Volume-2, Geotechnical testing and instrumentation, CBS Publishers and Distributors, New Delhi, 2006.
3. J. Dunnicliff and G.E. Green, Geotechnical Instrumentation for Monitoring Field Performance, John Wiley, 1993.
4. T. H. Hanna, Field Instrumentation in Geotechnical Engineering, Trans Tech., 1985.
5. C. R. I. Clayton, M. C. Matthews and N. E. Simons Site Investigation, Second Edition Halsted Press, 1982.

6. G. Ranjan and A.S.R. Rao, Basic and Applied Soil Mechanics, Wiley Eastern Limited, 1991.
7. J. E Bowles, Physical and Geotechnical Properties of Soil, McGraw-Hill Book Company, 1985.

Course Outcomes:

The students will be able to:

- Plan the subsurface investigation program for a given project also capable of extending consultancy service for real time Soil Mechanics and Foundation Engineering problems
- Apply the knowledge of different methods of exploration to select appropriate method of boring for investigating real field condition.
- Apply the knowledge of different sampling techniques to collect, store and transport soil samples from onshore and offshore to meet specified needs and also to characterize the soil.
- Plan the instrumentation programme, execute the same in the field and monitor the performance of geotechnical structures to ensure its stability during its life time.

| | | |
|--------------------------|----------|-------------------------------------|
| Course Code | : | TEN 626030 |
| Course Title | : | Road Safety |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

To learn the basic and advance road safety parameters including traffic regulatory objects and bodies including its evaluation techniques.

Course Content:

| Unit | Content | Hours |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Introduction to safety: Road accidents, Trends, Causes, Collision and Condition diagrams, Highway safety, Human factors, Vehicle factors Road Safety Management System: Multi causal dynamic systems approach to safety, Crash vs accident, Road safety improvement strategies, Elements of a road safety plan, Safety Data Needs. | 08 |
| II | Statistical Interpretation and Analysis of Crash Data: Before-after methods in crash analysis, advanced statistical methods. Black Spot Identification & Investigations, Case Studies. | 10 |
| III | Road Safety Audits: Key elements of a road safety audit, Road Safety Audits & Investigations, Crash investigation and analysis, Describe methods for identifying hazardous road locations, Case Studies | 10 |
| 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 | 7 |

| | | |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| | pedestrian crashes. | |
| 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. | 10 |

Recommended Books/References

1. S. K. Khanna and C. E. G. Justo, Highway Engineering, Nem Chand & Bros, 19891.
2. L. R. Kadyali and N. B. Lal, Highway Engineering, Khanna Book Publishing Company (P) Limited, 2017.
3. S. P. Bindra, A Course in Highway Engineering, Dhanpat Rai Publications, 2003.

Course Outcomes:

The students will learn:

- The essential elements of road safety measures and its evaluation methods followed.
- To learn the how to prevent accidents by better planning roads

| | | |
|--------------------------|---|-------------------------------------|
| Course Code | : | TEN 626040 |
| Course Title | : | Operations Research |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The objective of this course is to provide strong foundation for understanding the fundamental principles and laws of Operation Research to understand Linear, network Analysis, queuing and about project management.

Course Content:

| Unit | Content | Hours |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models | 10 |
| II | Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming | 15 |
| III | Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT | 12 |
| IV | Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models | 8 |

Recommended Books/References

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008.
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.

3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008.
4. H. Libermann, Operations Research: McGraw Hill Pub. 2009.
5. Pannerselvam, Operations Research: Prentice Hall of India 2010.
6. H. M. Wagner, Principles of Operations Research: Prentice Hall of India 2010.

Course Outcomes:

The students will learn to:

- Identify and develop operational research models from the verbal description of the real system.
- Understand the mathematical tools that are needed to solve optimization problems.
- To apply dynamic programming techniques to solve the complex problem.

| | | |
|--------------------------|----------|-----------------------------------------|
| Course Code | : | TEN 626050 |
| Course Title | : | Intersection Design and Analysis |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

1. To define and explain the necessity of different types of intersection planning and their design.
2. To provide detailed knowledge of controlled and uncontrolled signal design with a focus on vehicle and pedestrian movement.
3. To develop an in-depth understanding of the placement of traffic control devices, and alteration of existing intersection geometry.

Course Content:

| Unit | Content | Hours |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Types of intersections, Principles of design, types of maneuvers, relative speed, conflict points and area. | 10 |
| II | Intersection geometrics and their influence on design/operation. Concept of capacity and LOS, Operational analysis of two-way and all-way stop controlled intersections and Roundabouts by US and Indian methods, mini roundabouts. | 15 |
| III | Analysis of signal-controlled intersections by US, British and Swedish methods, delay and its evaluation. Types of signals, Design of signals by Indian, US and British methods, signal coordination. | 15 |
| IV | Grade separated intersections and interchanges, weaving sections and their operational evaluation, Intersection signs, marking and lighting | 5 |

Recommended Books/References

1. C. S. Papacostas and P. D. Prevedouros, Transportation Engineering & Planning, Prentice Hall of India Private Limited, New Delhi, 2001.
2. F. L. Mannering, Walter P. Kilareski and Scott S. Washburn, Principles of Highway Engineering and Traffic Analysis, Wiley India Edition, 2007.
3. C. Jotin Khistya and B. Kent Lall, Transportation Engineering, Prentice Hall of India Private Limited, New Delhi, 2006.
4. C. A. O. Flaherty, Transport Planning and Traffic Engineering, Hodder Headline Group, London, 1997.
5. Highway Capacity Manual of US, Transportation Research Board, Washington DC. 2010.

Course Outcomes:

The students will learn:

- To utilize traffic simulation tools to model intersection operations.
- To implement sustainable transportation concepts in intersection design.
- To analyse real-world case studies of successful and unsuccessful designs.

| | | |
|--------------------------|----------|-------------------------------------|
| Course Code | : | TEN 626060 |
| Course Title | : | Transportation Economics |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The main objective of this course is to give broad insight into the different facets of transportation systems, while providing a solid introduction to transportation demand and cost analyses, Covers the key principles governing transportation planning.

Course Content:

| Unit | Content | Hours |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Overview of Transportation Economics; Transportation Investments and economic Development. | 10 |
| II | Basics of Engineering economics, marginal analysis, opportunity cost, shadow price, money value of time, discounted cash flow, Page 2 NPV, ROR, benefit-cost analysis. | 15 |
| III | Road User Costs; Public transportation economics; Social Cost of Transportation; Cost of congestion, pollution, traffic accidents. | 15 |
| IV | Taxation, regulations, financing Transport Systems; Legal framework for transportation sector, case studies. | 5 |

Recommended Books/References

1. Richard de Neufville, Applied Systems Analysis: Engineering Planning and Technology Management, Mcgraw-Hill International Edition.
2. D. W. Pearce, R. Kerry Turner, Economics of Natural Resources and the environment, The John Hopkins University Press, USA.

3. Emile Quinet and Roger Vickerman, Principles of Transport Economics, Edward Elgar Publishing, 2004
4. Christopher Nash and Bryan Matthews eds. Measuring the marginal Social Cost of transport, Research in transportation Economics, vol.14, Elsevier, 2005.
5. K. A. Small, Urban Transportation economics, Harwood Academic Publishers, 1992.
6. Sergio Jara-Diaz, Transport Economic Theory, Elsevier, 2007.

Course Outcomes:

The students will understand to:

- Critically assess transportation policies and regulations from an economic standpoint.
- Grasp the economic implications of different financing options and investment decisions in transportation.
- Comprehend the spatial dimensions of transportation economics and its role in regional development.
- Consider environmental factors in transportation decision-making and assess sustainable alternatives.
- Compare public and private transportation systems based on economic efficiency and equity.
- Analyze real-world case studies to apply theoretical concepts to practical transportation scenarios.

| | | |
|--------------------------|----------|--------------------------------------|
| Course Code | : | TEN 626070 |
| Course Title | : | Highway Construction Practice |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The objective of the course is to introduce students to the construction practices for highways, covering all aspects of construction procedures and quality control.

Course Content:

| Unit | Content | Hours |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Road planning and reconnaissance; road construction techniques: construction staking, clearing and grubbing of the road construction area | 8 |
| II | Construction of subgrade: excavation and filling, compaction, preparation of sub grade, quality control tests, Construction of granular subbase, Construction of dry lean concrete subbase, Construction of granular layer, use of geo-textiles and geo-grids. | 15 |
| III | Construction of bituminous layers – bituminous McAdam, dense bituminous Mcadam, bituminous concrete. | 12 |
| IV | Construction of concrete pavements, Construction of embankments, Construction of non-conventional pavements. | 10 |

Recommended Books/References

1. MOST, Specifications for Road and Bridge Work (4th Revision), Ministry of Road Transport and Highways, 2001.
2. R. N. Hunter, Bituminous Mixtures in Road Construction, Thomas Telford Services Ltd., 1995.
3. C. H. Oglesby, and R. G. Hicks, Highway Engineering, John Wiley & Sons, 1982.
4. Coleman O'Flaherty (ed.) Highways-The Location, Design, Construction and Maintenance of Road Pavements, ICE Publishing 5th edition, 2015. ISBN: 9780727759931

Course Outcomes:

The students will learn:

- About techniques used for the construction of different component of pavement.
- About the earthwork and equipment used for highway construction.
- About the application of reinforcement techniques for pavement construction.
- About the construction of rigid and flexible pavement using non-conventional way.

| | | |
|--------------------------|----------|-----------------------------------------------------------------|
| Course Code | : | TEN 626080 |
| Course Title | : | Hill Road Planning, Design, Construction and Maintenance |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The objective of this course is to make students to gain knowledge on designing roads in hilly and rural areas.

Course Content:

| Unit | Content | Hours |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Importance of Hill roads, Classification, Terrain classification, Planning and Alignment: Data base for master plan, Concept of network planning, Road alignment, Governing factors for route selection, Factors controlling alignment, Special considerations while aligning hill roads, Surveys, Detailed project report, Environmental issues. | 12 |
| II | Geometric Design: Introduction, Design speed, Basic principles of geometric design, Elements, Horizontal and vertical alignment, Alignment compatibility, Lateral and vertical clearances. Road Materials: General, Soil and material surveys, Soil as road construction material, Stabilized soils, Aggregates for pavement courses, New materials and stabilizers, Materials for bituminous construction, Materials for semi-rigid and rigid pavement, Materials for special pavements Climatic suitability of concrete materials. | 15 |
| III | Pavement Design: Introduction, Design parameters, Pavement components, | 15 |

| | | |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| | Design of flexible pavement, Design of semi-rigid pavement, Design of rigid pavement, Design of special pavements, Drainage and Shoulders Specifications and Construction: General, Selection of construction materials and methodology, Earthwork, Sub-base, Base course, Bituminous constructions, Semi-rigid pavement construction, Concrete pavements, | |
| IV | Construction of special pavements, Equipment required for different operations | 3 |

Recommended Books/References

1. IRC: SP 20-2002 "Rural Roads Manual".
2. IRC: SP 72-2007 "Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads".
3. IRC: SP 62-2004 "Guidelines for the Design and Construction of Cement Concrete Pavements for Rural Roads".
4. IRC "Specifications for Rural Roads", MoRD, 2004.

Course Outcomes:

The students will learn:

- About the hill road, its type, factors controlling route selection, alignments and survey.
- About the geometric design of hill road.
- About the design of different types of pavement of hill road.
- About the equipment used in hill road construction.

| | | |
|--------------------------|---|-------------------------------------|
| Course Code | : | TEN 626090 |
| Course Title | : | Transport and Environment |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The objective of this course is to gain a thorough understanding of different transportation modes (road, rail, air, water) and their components, operations, and infrastructure. Analyze the environmental impacts of transportation systems, including air and noise pollution, greenhouse gas emissions, energy consumption, land use, and their effects on climate change and local ecosystems.

Course Content:

| Unit | Content | Hours |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Modes of Transportation, Sources of air pollution, Mixed traffic flow, Transport related pollution, Road transport related air Pollution, Air Transport Related Air pollution, Effects of Weather Conditions. | 10 |
| II | Vehicular emission parameters, Pollution standards, Measurement and analysis of vehicular emission, Predicting Air pollution concentration: Pollution dispersion model, Plume rise model, Mitigative Measures, Air pollution Index. | 15 |

| | | |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| III | Water Transport Related pollution, impact on water quality, flora, fauna, Mitigative measures. Urban and non-urban traffic noise sources, Noise level factors, Effects of traffic noise. | 15 |
| IV | Propagation and measurement of traffic noise, Prediction and control measures, Noise studies, Noise standards. Technology Vision-2020, Energy related aspects of different transport technologies. | 5 |

Recommended Books/References

1. K. Wark, C.F. Warner and W.T. Davis, Air Pollution: Its Origin and Control, Prentice Hall. 3rd Ed. 1997.
2. R.W. Boubel, Fundamentals of Air Pollution, Academic Press, 4th Ed. 2007.
3. D. Vallero, Fundamentals of Air Pollution, Academic Press, 4th Ed. 2007.
4. L. Canter, Environmental Impact Assessment, McGraw-Hill International, 2nd Ed. 1995.
5. J.G. Henry and G. W. Heinke, Environmental Scientific Engineering, Second Edition, Prentice Hall of India, Pvt.ltd. New Delhi
6. M. N. Rao and H. V. N Rao, Air Pollution, Tata McGraw Hill Publication Company limited, New Delhi.

Course Outcomes:

The students will learn to:

- Grasp the complex interplay between transportation systems and their environmental impacts.
- Understand national and international regulations addressing transportation-related environmental issues.
- Recognize the role of policies in minimizing negative environmental effects.
- Identify emission sources from different transportation modes and their impact on air quality.
- Evaluate strategies to mitigate air pollutants and enhance urban air quality.

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|--------------------------|---|--------------------------------------------|
| Course Code | : | TEN 626100 |
| Course Title | : | Airport Systems Planning and Design |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

Gain a comprehensive understanding of the various components that constitute an airport system, including airside, landside, terminals, runways, taxiways, and navigational aids.

Course Content:

| Unit | Content | Hours |
|-------------|-----------------------------------------------------------------------------------------------------------------|--------------|
| I | Visual Aids: Airport Day time markings, airport lighting, visibility, visual aids | 10 |
| II | Structural design of airport pavements: Design Factors, Design of flexible and rigid pavements using FAARFIELD. | 15 |

| | | |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| III | Airside capacity and delay: mathematical models for capacity and delay, space time concept, models for mixed traffic. Air Traffic Control: Importance of flight rules, navigational aids. | 15 |
| IV | Air Traffic Control: controls, obstruction and clearance requirements. Design of heliports. | 5 |

Recommended Books/References

1. Robert Horonjeff and Francis X. McKelvey, Planning & Design of Airports, McGraw Hill, Inc, 1993.
2. S. K. Khanna, M. G. Arora and S. S. Jain, Airport Planning & Design, Nem Chand and Bros. Roorkee, 2004.
3. N. Ashford and P. H. Wright, Airport Engineering, John Wiley & Sons, NY., 1992.
4. ICAO, Aerodrome Design Manual, International Civil Aviation Organization, Montreal, Canada, 1988.

Course Outcomes:

The students will learn to:

- Understand the various components of airport systems, including airside and landside operations, terminals, runways, and taxiways.
- Grasp the foundational principles of airport planning, including site selection, capacity assessment, and long-term master planning.
- Gain insights into terminal layout, passenger flow optimization, baggage handling systems, and security considerations.

| | | |
|--------------------------|----------|-------------------------------------|
| Course Code | : | TEN 626110 |
| Course Title | : | Mass Transit System |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

Main objectives of this course is to teach students about handling of huge intra-city traffic for highly populated urban areas by application of optimum construction methodologies for intra-city Transportation systems along with railway safety, Railway alignment and track design.

Course Content:

| Unit | Content | Hours |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Mass transit concepts trip interchanges and assignments Urban transportation problems, Modes of mass transit- their planning, construction and operation, Case studies of existing mass transit systems | 15 |
| II | Technical and economic evaluation of mass transit projects History and role of public transportation in urban development Urban passenger transport modes Vehicle characteristics and motion Highway transit modes: Buses and trolleybuses | 15 |
| III | Rail transit modes: street cars, light rail, rapid transit and regional rail New concepts and proposed modes | 5 |

| | | |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| IV | Bus rapid transit system Principles of bus rapid transit system Lane priority Contraflow lanes Bus rapid transit: a sustainable approach to mass transit Rapid transit systems Para-transit system Transportation systems. | 10 |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|

Recommended Books/References:

1. C. S. Papacostas and P. D. Prevedouros, Transportation Engineering and Planning, PHI Publication, 2001.
2. S. Grava, Urban Transportation Systems, Mc. Graw Hill Professional, 2003.
3. J. D. Fricker and R.K. Whitford, Fundamentals of Transportation Engineering, Pearson, PH, 2004.
4. J. E. Anderson, Transit Systems Theory, Lexinton Books, 1978.

Course Outcomes:

After completion of this course students will have mastery on efficient Transportation system operation and will

- Handle huge intra-city traffic for highly populated urban areas
- Know about the optimum construction methodologies for intra-city Transportation systems
- Have knowledge on Railway safety
- Have knowledge on Railway alignment and track design

| | | |
|--------------------------|----------|-------------------------------------|
| Course Code | : | TEN 626120 |
| Course Title | : | Reinforced Soil Structures |
| Number of Credits | : | 3 (L: 3, T: 0, P: 0) |
| Course Category | : | Professional Elective Course |

Course Objective:

The objective of this course is to understand students about reinforced soil, its mechanism, types of reinforcement, their properties and function; and design of different reinforced soil structures.

Course Content:

| Unit | Content | Hours |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Historical background; Principles, concepts and mechanism of reinforced earth; Design consideration for reinforced earth and reinforced soil structures | 8 |
| II | Geosynthetics-their composition, manufacture, properties, functions, testing and applications in reinforced earth structures. | 7 |
| III | Design of reinforced soil structures like retaining walls, embankments, foundation beds | 15 |
| IV | Designing for Separation, Filtration, Drainage and Roadway Applications; Designing for Landfill Liners and Barrier Applications; Case histories of applications. | 15 |

Recommended Books/References

1. C.R.I. Clayton, J. Milititsky and R.I. Woods, Earth Pressure and Earth Retaining Structures, Blackie Academic & Professional, 1993.
2. T. Ingold, Reinforced Earth, Thomas Telford Ltd., 1982.
3. C. J. F. P Jones, Earth Reinforcement and Soil Structures, Butterworth, 1985.
4. R.M. Koerner, Designing with Geosynthetics, Prentice Hall, 1993.
5. G. L. Sivakumar Babu, An introduction to Soil reinforcement and geosynthetics, United Press (India) Pvt. Ltd., 2006.
6. G. V. Rao, S. J. Kumar and G.V.S.S. Raju, (Eds.). Earth Reinforcement – Design and Construction. Publication No. 314, Central Board of Irrigation and Power, New Delhi, 2012.

Course Outcomes:

The students will be able to:

- Know about different reinforcement types and their functions.
- Know about the working mechanism of reinforcement in earth structures.
- Know about the design of earth structure including foundation, pavement, retaining structure, embankment.
- Handle projects of the design of reinforced soil structure

| | | |
|--------------------------|----------|-------------------------------------------------|
| Course Code | : | TEN 622030 |
| Course Title | : | Transportation Engineering Laboratory-II |
| Number of Credits | : | 1 (L:0,T:0, P:2) |
| Course Category | : | Laboratory Course |

Course Objective:

Transportation Engineering Laboratory fulfills the needs of analyzing the traffic movements and testing the pavement materials. In this course, the analysis of traffic movement is to be done.

Course Content:

| Experiment Number | Name of Test |
|--------------------------|-------------------------------------------------------------------------------------------------------------|
| 1 | To acquire information on daily travel characteristics to understand travel behaviour of individuals. |
| 2 | To find out instantaneous speed of the different vehicle at a given stretch along with its characteristics. |
| 3 | To carry out classified traffic volume counts and calculate peak hour factor for the observation. |
| 4 | To identify the three fundamental parameters of a stream |
| 5 (a) | To find out parking load, parking accumulation and parking index using patrol method. |
| 5 (b) | To find out parking load, parking accumulation and Parking index using in-out |

| | |
|--|----------------|
| | survey method. |
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Recommended Books/References

1. ITE Manual of Transportation Engineering Studies, 2nd edition
2. L. R. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publishers, New Delhi, 1987

Course Outcome:

The students will be able to learn are the important parameters for the design of traffic infrastructure or traffic facilities by knowing

- The travel behavior,
- The spot speed, traffic volume study,
- The traffic stream characteristics and
- Parking study

| | | |
|--------------------------|----------|---------------------------------|
| Course Code | : | TEN 624040 |
| Course Title | : | Mini Project |
| Number of Credits | : | 2 (L:,T:0, P:4) |
| Course Category | : | Professional Core Course |

Course Objective:

The objective of this course is to learn students about literature review of any topic of Transportation Engineering domain.

Course Content:

The mini project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals’ contribution.

Course Outcome:

The students will be able to learn

- The methods of literature review.
- The skill of identifying the research problem based on literature review.
- The skill of finding different methodology to solve the identified problem.
- The skill of report/thesis writing based on his study.

| | | |
|--------------------------|----------|-------------------------------------|
| Course Code | : | AUD626051 |
| Course Title | : | AUD II (Disaster Management) |
| Number of Credits | : | 0 (L: 2, T: 0, P: 0) |
| Course Category | : | Audit Course |

Course Objective:

The objective of this course is to learn students regarding disasters and its management.

Course Content:

| Unit | Content | Hours |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| I | Understanding Disasters: Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, and Capacity – Disaster and Development, and disaster management. Types, Trends, Causes, Consequences and Control of Disasters: Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Man-made Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters | 8 |
| II | Disaster Management Cycle and Framework: Disaster Management Cycle – Paradigm Shift in Disaster Management, Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR, Yokohama Strategy, Hyogo Framework of Action | 7 |
| III | Disaster Management in India: Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies | 7 |
| IV | Applications of Science and Technology for Disaster Management: Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development Regulations Disaster Safe Designs and Constructions Structural and Non Structural Mitigation of Disasters S&T Institutions for Disaster Management in India | 8 |

Recommended Books/References

1. D. P. Coppola, Introduction to International Disaster Management, Elsevier Science (B/H), London, 2007
2. World Disasters Report, International Federation of Red Cross and Red Crescent, Switzerland, 2009.
3. S. L. Goyal, Deep & Deep, Encyclopedia of disaster management, Vol I, II and III. Disaster management policy and administration, New Delhi, 2006.
4. Anu Kapur and others, Disasters in India Studies of grim reality, Rawat Publishers, Jaipur, 2005.

5. H.N. Srivastava & G.D. Gupta, Management of Natural Disasters in developing countries, Daya Publishers, Delhi, 2006.
6. David Alexander, Natural Disasters, Kluwer Academic London, 1999.
7. National Disaster Management Policy, GoI, 2009.

Course Outcomes:

The students will learn:

- About different types of disasters.
- Regarding the various management skills for managing the disasters.
- About various government acts and policy to manage the disasters.
- About the application of different technologies to manage the disaster.