# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Master of Engineering**

**Level: PG**

**Branch: Civil Engineering (Transportation Engineering)**

**Course/Subject Code: ME02069031**

**Course/Subject Name: Advances in Transportation Engineering**

| | |
|---|---|
| w. e. f. Academic Year: | 2024-25 |
| Semester: | 2 |
| Category of the Course: | Professional Elective Course |

| | |
|---|---|
| **Prerequisite:** | Transportation Engineering, Traffic Engineering |
| **Rationale:** | Transportation Engineering plays an important role in the development of a nation. The transportation cost, travel time, delay due to congestion etc. can be reduced if implementation of Intelligent Transportation System (ITS) is done in transportation. It is necessary to understand the current ITS techniques used in transportation engineering. High-performance highway construction materials enhance durability, reduce maintenance, and improve safety by resisting heavy traffic and environmental stress. Incorporating sustainable materials minimizes environmental impact and ensures cost-effective, long-lasting road infrastructure. Alternative materials for road construction reduce waste, conserve resources, lower costs, and improve sustainability and durability. |

| No | Program Outcomes |
|---|---|
| 01 | Engage in critical thinking and research to develop solutions to multifold real-world problems. |
| 02 | Communicate effectively with the engineering community at large level on complex design tasks & write and present technical reports. |
| 03 | Demonstrate a high level of professionalism in handling multidisciplinary and complex engineering problems. |
| 04 | Plan, assess, create, integrate, carry out, and oversee complex engineering projects in a sustainable local and global context. |
| 05 | Address societal issues by offering technologically advanced, reasonably priced solutions while upholding high standards of ethics and professionalism. |

**Course Outcome:**

After Completion of the Course, Student will be able to:

| No | Course Outcomes | RBT Level |
|---|---|---|
| 01 | Identify various components of Intelligent transportation systems (ITS) and supporting technologies | A |
| 02 | Comprehend the role of ITS and its applications for improving the performance | N |

| | | |
|---|---|---|
| | of the transportation system | |
| 03 | Recognize various advanced materials for highway construction considering their high performance in the field. | A |
| 04 | Suggest alternative materials for road construction | E |

**Revised Bloom's Taxonomy (RBT)*

**Teaching and Examination Scheme:**

| Teaching Scheme (in Hours) | | | Total Credits L+T+ (PR/2) | Assessment Pattern and Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tutorial / Practical | | |
| L | T | PR | C | ESE (E) | PA / CA (M) | PA/CA (I) | ESE (V) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 20 | 30 | 150 |

**Course Content:**

| Unit No. | Content | No. of Hours | % of Weightage |
|---|---|---|---|
| 1. | **Introduction to Advanced Transportation Systems**: Overview of transportation engineering, emerging challenges in transportation, Sustainable transportation systems | 1 | 5 |
| 2. | **Intelligent Transportation System (ITS)**<br>**Introduction** - Historical Background, Benefits of ITS<br>**Advanced Traveler Information Systems (ATIS) -** Trip Planner and its impact, Traffic density measurement, Variable message signs, Parking guidance, Weather information and variable speed limits, Impacts of ATIS.<br>**Advance Vehicle Monitoring Systems**<br>Security CCTV systems, Wireless Sensor Network and RFID, Blue-tooth and Wi-Fi sensors, inductive loop detectors and image processing techniques, Impacts of AVMS.<br>**Commercial Vehicle Operations (CVO)**<br>Emergency vehicle notification systems, Automatic Road enforcement, Variable speed limits, Collision avoidance systems, Dynamic Traffic Light Sequence, Cooperative systems on the road, Automatic number plate recognition by Image processing, Impacts of CVO.<br>**ITS Applications** | 19 | 40 |

| | | | |
|---|---|---|---|
| | Advanced Traffic Management Systems (ATMS) Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS), Automated Highway Systems, and Framework for evaluating ITS related strategies, Smart vehicles, Smart highways, Adaptive Traffic Control System, Incident management, Driverless vehicles, Electronic Toll Collection, ITS and road-pricing, ITS and regional strategic transportation planning, including regional architectures: ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS and sustainable mobility, travel demand management.<br>**Intelligent Supporting Technologies**<br>Wireless communications, Standards and Cellular Technology, ITS Data acquisition and processing, Detectors/Detection Techniques, Global Positioning System (GPS). | | |
| 3. | **High Performance Highway Construction Materials:**<br>**Introduction, Use of waste materials:** Fly ash, Slag, Recyclable waste, other waste materials.<br>**Modified bituminous materials:** PMB, EMB, NRMB, CRMB, IS requirements and testing procedures. Modified Bitumen Emulsion and tests, Multi grade bitumen, Anti stripping additives,<br>**Micro surfacing:** procedure, testing.<br>**Super pave**: Binder specifications, Aggregates and testing, mixing, Gyratory Compactor.<br>**High performance mixes:** Stone Matrix Asphalt (SMA), fibers, mix design.<br>**Porous Asphalt:** mix, advantages.<br>**Fiber Reinforced Concrete:** Steel, asbestos, glass, polymer, carbon, natural fibers, applications.<br>**High Performance Concrete:** introduction, advantages, IS requirements, mineral admixtures, applications. | 19 | 40 |
| 4. | **Alternative Materials for Road Construction:** Necessity – Bitumen: production, replacement, uses – Aggregate: Production, replacement, uses – challenges in Subgrade preparation: Ground Improvement - Industrial wastes as construction materials – Natural fibres and textiles, Energy saving and carbon emission saving techniques, Pre-cast concrete elements for highway/railway construction. | 6 | 15 |
| | **Total** | **45** | **100** |

**Suggested Specification Table with Marks (Theory):**

| Distribution of Theory Marks (in %) | | | | | |
|---|---|---|---|---|---|
| **R Level** | **U Level** | **A Level** | **N Level** | **E Level** | **C Level** |
| **10** | **10** | **30** | **30** | **10** | **10** |

*Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)*

**References/Suggested Learning Resources:**
**(a) Books:**

1 AUSTROADS, The Implication of Intelligent Transport Systems for Road Safety, Austroads Incorporated, 1999.
2 Bob Williams, Intelligent Transport Systems Standards, Artech House Publishers, 2008.
3 Sumit Ghosh and Tony Lee, Intelligent Transportation Systems, CRC Press, ISBN: 0849300673.
4 Chris Drane and C. R. Drane, Positioning Systems in Intelligent Transportation Systems, Artech House Publishers, ISBN: 0890065365.
5 Judy Mc Queen and Bob Mc Queen, Intelligent Transportation System and Architecture, Artech House Publishers, ISBN: 089006525X
6 Asad J. Khattak , Intelligent Transportation Systems: Planning, Operations, and Evaluation, CRC Press
7 Chowdhary M A and A Sadek. Fundamentals of Intelligent Transportation systems planning. Artech House Inc., US, 2003.
8 M.A. Chowdhury and A. Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House, 2010.
9 R P Roess, S E Prassas, and W R McShane. Traffic Engineering. Pearson Education International, 2005.
10 Yokota Toshiyuki and Weiland Richard. Its standards for developing countries. (3), 2004.
11 Stough, R. Intelligent Transport Systems: Cases and Policies, Edward Elgar, 2001, Artificial Intelligence and Intelligent Transportation Systems, National Academy Press, 2010.
12 ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
13 S. Shah and S. Ahmad, High Performance Concretes and Applications, ButterworthHeinemann Publishers, ISBN: 0340589221

14 IRC 120, Recommended Practice for Recycling of Bituminous Pavements
15 IRC SP: 101, Guidelines for Warm Mix Asphalt
16 IRC SP: 79, Tentative Specification for Stone Matrix Asphalt
17 IRC, Guidelines for Design and Construction of Low Volume Rural Roads using Coir Geotextiles.
18 IRC: SP:100, Use of Cold Mix Technology in Construction and Maintenance of Roads using Bitumen Emulsion.
19 Kandhal P. S., Veeraragavan A., and Choudhury R., Bituminous Road Construction in India, PHI Learning, 2023.
20 Sherwood, P. T., Alternative Materials in Road Construction, Thomas Telford Ltd, 1995.
21 Specifications for Roads and Bridges, MoRTH, 5th Revision, 2013.
22 Wayne Lee and Kamyar Mahboub, Asphalt Mix Design and Construction: Past, Present, and Future State of the Practice: A Special Publication on the 150th Anniversary ofASCE, Publishers: ASCE, ISBN: 0784408424.

**(b) Open source reading material on website:**

1. https://nptel.ac.in/

**Suggested Course Practical List:**

1. Development of logic/algorithms for different ITS applications.
2. Tests on modified bituminous materials
3. Tests on modified bituminous mixes
4. Tests on fiber reinforced concrete

**Suggested Activities for Students:**

Field visits related to course such as

1 Visit to BRTS and any other places where ITS is applied,
2. Visit to Hot mix plant where modified bituminous materials or mixes are used.
3. Visit to Micro surfacing application.
4. Visit to road construction site where Fly ash is used.
5. Visit to road construction site where Fiber Reinforced Concrete or High-Performance Concrete is used.
6. Visit to factory of pre-cast concrete elements.

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