GUJARAT TECHNOLOGICAL UNIVERSITY

BE Semester-V
Subject Code: 3150613

Subject Name: PAVEMENT DESIGN AND HIGHWAY CONSTRUCTION

Type of course: Professional Elective Course-1

Prerequisite:

Rationale:
1. To Design appropriate Pavement for the roads
2. To enable the construction procedure of roads
3. To know the maintenance of the roads.
4. To know new techniques in the road construction.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Pavement Materials and Characterization**: ***Soil*** : Characterization for Earthwork, Subgrade. Effective CBR, Concept of Modulus of resilient of subgrade, ***Aggregate*** :Granular Subbase and Base layer - road aggregates used for WBM, WMM, Aggregate used in Bituminous layer, Its characteristics, gradation- Fullers equation, physical properties requirements for rural road and high-volume road., Concept of Modulus of resilient of sub base and base course as per IRC 37, ***Bituminous material*** : Bitumen, Emulsion, Modified bitumen, bituminous mix – Volumetrics, concept of modulus of resilient per IRC 37, Quality control and Quality Assurance plan for highway.	**5**
2	**Design of Highway Pavement :** ***Flexible Pavement*****:** Factors affecting pavement design, ESWL, EWLF, VDF, Stress analysis – Boussinesq's theory, Burmister's two- and three-layer theory, Flexible pavement design as performance criteria- subgrade rutting criteria and fatigue cracking criteria for bituminous layer. Pavement design using IITPAVE software for granular base and granular sub base, cementitious base, cementitious sub base. Overview on Pavement design for low volume road using locally available material as per IRC SP-72. Drainage consideration in pavement design	**15**

	Rigid Pavement: Design factors, Westergaard's stress analysis, load stress, temperature stress, Design based on fatigue behaviour of concrete, IRC-58 design method – Fatigue concept (using IIT RIGID), Design of joints, Friberg's analysis of dowel bar design, Design of tie bar. Overview on Pavement design for low volume road as per IRC SP-62	
3	**Construction of Pavement :** ***Flexible pavement*:** Construction procedure of embankment, subgrade, Sub base (Granular, sub base), Drainage layer, filter /separation layer, Base course-WBM, WMM, Lime stabilized, cement stabilized (Granular layer), Bituminous mix – Binder course and wearing course, its selection, its gradation, compaction and density requirements. Selection of different bituminous mix treatment as per functional and structural requirements of Construction procedure as per specification of MORTH ***Rigid pavement*:** Earthwork, Granular sub base, drainage layer, Dry lean concrete as per IRC-49, Pavement quality concrete construction requirements as per IRC:15 and IRC:58 and MORTH, Importance of joints and its provision Interlocking Concrete Block Pavement (ICBP) and Its procedure of laying, requirements, Pattern of blocks, Strength requirement as per guidelines of IRC SP 63.	**10**
4	**Maintenance of pavement** ***Flexible pavement*:** IRC-82, need of maintenance, types, planning, system approach, types of defects, symptoms, location, cause, severity level and treatment. Preventive and periodical renewals, its warrants and treatments. ***Rigid pavement*-** Maintenance and its methodology as per IRC: SP:83, Design of overlay.	**6**
5	**Introduction to New Technology** Recycle aggregate pavement as per IRC:120 (RAP), Cold in place (CIP), Hot in place (HIP), plant mix technology, Methodology of construction, Cold mix technology as per IRC SP-100, White topping – Conventional, Ultra-thin white topping as per IRC SP-76, , Stone matrix asphalt as per IRC SP-79, Warm mix asphalt as per IRC SP 101, Micro surfacing ,slurry seal as per IRC SP-81.	**6**

Course Outcomes: At the end of the course, Student will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Evaluate the physical properties of highway material	25
CO-2	Design the flexible and rigid pavement.	30
CO-3	Construct the flexible and rigid pavement as per standard specification.	25
CO-4	Evaluate the necessity of required maintenance and suggest suitable treatment	10
CO-5	Adapt new technology in the highway construction.	10

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Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10%	**20%**	**20%**	**20%**	**15%**	**15%**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books

1. Huang Y. H., Pavement Analysis and Design. Prentice Hall, Englewood Cliffs, New Jersey, USA, 1993, ISBN-0-13-655275-7
2. Yoder E. J. and Witczak M. W., Principles of Pavement Design, John Wiley and Sons, New York, 1975
3. Dr. Sharma S. K., Principles, Practice and Design of Highway Engineering (Including Airports), S. Chand & Company Ltd.
4. Chakraborty Partho, Das Animesh, Principles of Transportation Engineering, PHI
5. Khanna S.K., Justo C.E.G., Highway Engineering, Nem Chand & Bros., Roorkee.
6. Kadiyali L. R. and Lal, N. B., Principles & Practice of Highway Engineering, Khanna Publishers, Delhi.
7. Martin Rogers, Bernard Enright, Highway Engineering, Willey Blackwell
8. Paul H. Wright, Karen K. Dixon, Highway Engineering, John Wiley & Sons, 7th edition, 2004
9. Specifications for Road and Bridges, Ministry of Road Transport & Highways (MoRTH)
10. Rao G.V. Principles of Transportation and Highway Engineering, Tata McGraw-Hill Publishing Company Ltd., New Delhi, India, 1996.
11. Huang, Y.H. Pavement Analysis and Design, Pearson Prentice Hall, New Jersey, USA, 2004.

IRC Codes

1. IRC 82-2015 Code of practice for maintenance of bituminous surfaces of highways
2. IRC: SP:83 2015 - Maintenance & Rehabilitation of Cement Concrete Pavements
3. IRC : 37-2018 – Guidelines for the design of flexible pavement
4. IRC : 58-2015 - Guidelines for the design of plain jointed rigid pavement for highways
5. IRC :15 -2017: Standard specification and code of practice for construction of concrete roads
6. IRC SP 72-2015 - Guidelines for design and construction of flexible pavement for low volume road
7. IRC SP 63 Guidelines for the Use of Interlocking Concrete Block Pavement
8. IRC –SP-62-2014 – Guidelines for design and construction of cement concrete pavement for low volume road
9. IRC 120 Recycling of Bituminous Pavements
10. IRC SP-100 Use Of Cold Mix Technology In Construction And Maintenance Of Roads Using Bitumen Emulsion
11. IRC SP-81 Specifications For Slurry Seal And Microsurfacing

12. IRC SP-101 Guidelines for Warm Mix Asphalt
13. IRC SP-76 Guidelines for Conventional Thin White-Topping
14. IRC SP 49-2014 Guidelines Of Use of Dry Lean Concrete as Sub-Base Course For Rigid Pavement

List of Experiments:

1. Bituminous mix design
2. Determination of CBR value of various mix
3. Determination of overlay thickness

Tutorial

1. Examples on stress analysis of flexible pavement for single layer, two layer and multi-layer

2. Problem on case study on design of Flexible pavement for NH/SH using IIT PAVE for granular sub base and base course

3. Problem on design of rural road

4. Problem on stress analysis of rigid pavement as per Westergaard theory

5. Design of dowel bar as per Friberg's analysis and design of tie bar

6. Design of Rigid pavement for fatigue damage as per IRC:58 using IITRIGID

Major Equipment:

1. Marshal Stability Test
2. California Bearing Ration Test
3. Benkelman Beam/Falling weight deflectometer

List of Open Source learning website:

1. http://www.nptel.iitm.ac.in/courses/

Field Visit :

1. A visit of construction site of Highway for understanding of construction procedure of flexible and rigid pavement
2. A visit of Ready-Mix Concrete plant for understanding of process of producing concrete