GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Civil Engineering (Transportation Engineering)

Subject Code: ME02069011

Course/Subject Name: Pavement Design, Construction and Evaluation

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

Prerequisite:	Transportation Engineering, Traffic Engineering
Rationale:	It is required to upgrade the knowledge of current practices in design of pavement structures. The objective of the course is to introduce the basic concepts of analysis and design of pavement structure. The current trends in design considering cumulative fatigue damage due to the combined effect of load and pavement temperature in rigid pavement are included in the present study. The study of recent development in design considering fatigue resistant mix and rut resistant mix for improving properties of various bituminous mix are also included. It includes the study of various types of failures of pavement and its remedial measures. It is necessary to reduce the cost of repairs and maintenance. The knowledge of construction techniques of various types of roads is backbone for the students. Various evaluation techniques are also covered in the course.

Course Outcome:

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

No	Course Outcomes	RBT Level
01	Design a flexible pavement using various methods.	N, E
02	Design a rigid pavement using various methods	N, E
03	Understand various road construction methods, including flexible, rigid pavement along with components, specifications, and testing procedures.	U
04	Evaluate the causes of failures in road construction under specific conditions and proposes appropriate preventive measures.	E
05	Explain techniques for evaluating pavement strength, serviceability, and maintenance, along with methods for strengthening and suggested remedies.	U, A

**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

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L	T	PR	C	Theory		Tutorial / Practical		
				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:** Types of Pavements – Rigid, Flexible, Highway-Runway Comparison. explore innovative design methods that were developed to investigate distress mechanisms of pavements including alternatives intended to address some environmental performance goals, investigate decision making and design tools that will encourage the use of more sustainable pavement materials and structures, such as permeable pavements, rubber asphalt, recycled asphalt pavement (RAP) and alternative cement binders, and discuss possible applications of pavement design strategies that can have a considerable impact on fuel consumption, vehicle maintenance costs, Green House Gas (GHG) emissions, and life-cycle costs.	04	9
2	**Analysis and Design of Flexible pavement:** Factors Affecting Pavement Design: Variables considered in pavement design; classification of axle types, standard and legal axle loads, tyre pressure, contact pressure, ESWL, EWLF, and EAL concepts; traffic analysis: ADT, AADT, truck factor, growth factor, lane distribution factor, directional distribution factor, and vehicle damage factor. Stresses in Flexible Pavements – Theories and Analysis. Burmister's 2 layer and 3-layer theories, Stress analysis in flexible pavements using KENLAYER. Design of Flexible Pavements –Various Methods for Highway and Runways Design. Design of flexible pavements as per AASHTO (1993), MEPDG and IRC 37:2018 IITPAVE Mix Designs– Bituminous Mixes, Admixtures, Marshall Stability Test, Results, Control.	10	22
3	**Analysis and Design of Rigid Pavement:** Stresses in Rigid Pavements – Theories and Analysis. Types of Stresses and Causes, Factors influencing Stresses in rigid pavements, EWLF; Wheel Load Stresses, Warping Stresses, Friction Stresses, Types of Joints in Cement Concrete Pavements and their Functions, Joint Spacing, Stress analysis in rigid pavements using, KENSLABS.	10	22

	Design of Rigid Pavements – Various Methods for Highways and Runways, Design of Slab Thickness, Design of Joint Details for Longitudinal Joints, Contraction Joints and Expansion Joints, Design of rigid pavements as per IRC 58:2015, IITRIGID and AASHTO method. Design of continuously reinforced rigid pavement and Pre-stressed Concrete Pavements.		
4	**Highway Construction Methods:** Embankment, Sub- Base, Base and Surface Courses, Bituminous Pavement Construction, Cement Concrete Construction, Materials for road construction, Specification and tests, Macadam construction, surfacing and surface treatment, Road Work in Desert, Swampy, Hilly Area in Problematic Situation	09	20
5	**Pavement Drainage:** Surface and Subsurface Drainage, Detrimental effects of water, methods for controlling water in pavements, Drainage materials: aggregates, geotextiles, pipes, Estimation of inflow, determination of drainage capacity, Drainage design for urban roads and rural roads as per IRC codes.	04	9
6	**Pavement evaluation and strengthening:** Failures in flexible and rigid pavements, pavement evaluation, deflection survey, serviceability rating techniques, strengthening techniques, maintenance, overlays, replacements	08	18
	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**
30	**20**	**30**	**10**	**10**	**--**

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

(a) Reference Books:

1. E. J. Yoder and M. W. Witczak, Principles of Pavement Design, John Wiley and Sons, New York, 1975
2. Sharma &Shrama, Principles and Practice of Highway Engg.
3. Y. H. Huang, Pavement Analysis and Design. Prentice Hall, Englewood Cliffs, New Jersey, USA, 1993, ISBN-0-13-655275-7

4. H.N. Atkins, Highway Construction and Maintenance, Soils, and Concretes, Reston Publishing Company, Reston VA, 1983.
5. J. P. Watson, Highway Construction and Maintenance, Longman Scientific and Technical, New York, 1989.
6. Relevant IRC, BIS, AASHTO and PCA Specifications and Guidelines.
7. Kadiyali L. R. and Lal, N. B., Principles & Practice of Highway Engineering, Khanna Publishers, Delhi.
8. Khanna S.K., Justo C.E.G., Highway Engineering, Nem Chand & Bros., Roorkee.
9. Partho Chakraborty and Animesh Das, Principles of Transportation Engineering, PHI
10. F. L. Mannering, W. P. Kilareski and S. S. Washburn, Principles of Highway Engineering and Traffic Analysis. Wiley India Pvt. Ltd., New Delhi.
11. Yoder, E.J., and Witczak, M.W., Principles of Pavement Design, Wiley India Pvt. Ltd., New Delhi, India, 2012, Second Edition.
12. IRC37-2018 Guidelines for the Design of Flexible Pavements
13. IRC58-2015 Guidelines for the Design of Plain Jointed Rigid Pavements for Highways
14. IRC 117-2014 Guidelines for the Structural Evaluation of Rigid Pavement by Falling Weight Deflectometer.
15. IRC 115-2014 Guidelines for Structural Evaluation and Strengthening of Flexible Road Pavements Using Falling Weight Deflectometer (FWD) Technique.
16. MoRTH , Specifications of Road and Bridge Works, 5th Revision 2013
17. IRC 82-2015 Code of practice for maintenance of bituminous surfaces of highways
18. IRC SP83-2015 Maintenance & Rehabilitation of Cement Concrete Pavements
19. IRC 15-2017 Standard specification and code of practice for construction of concrete roads
20. IRC 120-2015 Recycling of Bituminous Pavements

(b) Open-source software available on website:

1. IITPAVE
2. KENPAVE

(c) MOOC Course link:

1. Pavement material- https://nptel.ac.in/courses/105107219
2. Analysis and Design of Bituminous Pavement- https://archive.nptel.ac.in/courses/105/106/105106221/

(d) Online Resources:

1. http://onlinepubs.trb.org/onlinepubs/archive/mepdg/guide.htm

2. http://www.trb.org/Pavements/TRBPublications.aspx
3. https://link.springer.com/article/10.1007/BF03325749
4. https://pavementinteractive.org/

(e) List of Tutorials:

1. Problem based on based on analysis for flexible and rigid pavement
2. Tutorials based on design of flexible pavements.
3. Tutorials based on design of rigid pavements.
4. Tutorials based on design of overlays.
5. Tutorials based on the pavement evaluation and strengthening.

(f) List of Laboratory/Learning Resources Required:

1. Plate bearing test
2. Field CBR test
3. Pavement Evaluation by Benkelman Beam Method/Falling Weight Deflectometer
4. Road Unevenness Measurement by Bump-Integrator.
5. Evaluation of Pavement Roughness by Roughometer / Profilometer
6. Marshall stability test, Mix Design for BC/DBM

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