GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering
Level: PG
Branch: Civil Engineering(65)
Course / Subject Code: ME01065081
Subject Name :Advanced Pavement Design and Construction

w. e. f. Academic Year:	2024-2025
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	Transportation Engineering
Rationale:	For the infrastructure development of India, the Government has started ambitiou splans for upgrading of the National Highways in a phased manner. 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. The knowledge of construction techniques of various types of roads is backbone for the students.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Comprehend the behavior of pavement based on material characteristics and factors affecting the design of pavement to be considered.	R,U
02	Analyse the pavement by considering various stress input parameters appropriately.	U,A,N
03	Design the flexible and rigid pavement by various methods with the guidelines given by IRC, AASHTO, and PCA.	A,N
04	Describe various methods of construction of different types of roads and their components, specifications and tests.	A,N, 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.	Pavement Materials: Component parts of pavements, Types of Pavements – Rigid, Flexible, Basic characteristics of materials used in pavements. 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	7	15
2.	Stresses in Flexible Pavements: Theories, Fundamental design concepts, Layered system concepts, Analysis. Design of Flexible Pavements,ESWL, Tyre Pressure, Other Factors, Various Methods for Highway Design, Mix Designs– Bituminous Mixes, Admixtures, Marshall Stability Test.	7	20
3.	Design Of Flexible Pavement: IRC method of flexible pavement design, Asphalt Institute's methods with HMA and other base combinations, MEPDG method of flexible pavement design, Design of flexible pavement shoulders; problems.	8	15

4.	Stresses in Rigid Pavements: Westergaard's theory and assumptions, Stresses due to curling, stresses and deflections due to loading, frictional stresses, Stresses in dowel bars and tie bars, Stress analysis in rigid pavements. Design of Joints, Temperature stresses. Pre-stressed Concrete Pavements.	**7**	**15**
5.	Design Of Rigid Pavements: IRC method of plain jointed and continuously reinforced rigid pavement design, MEPDG method of rigid pavement design, Design of rigid pavement shoulders. Design of Joints; problems.	**8**	**15**
6.	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, RoadWork in Desert, Swampy, Hilly Area in Problematic Situation.	**8**	**20**
	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. 27. Papagiannakis, A.T. and E.A. MasadPavement Design and Materials, John Wiley and Sons, New Jersey, USA, 2008.
2. Asphalt Institute. Thickness Design – Asphalt Pavements for Highways and Streets Manual Series No. 1 (MS-1), Asphalt Institute, Kentucky, USA, 1999.
3. Das, A. Analysis of Pavement Structures, CRC Press, Taylor and Francis Group, Florida, USA, 2015.

4. E. J. Yoder and M. W. Witczak, Principles of Pavement Design, John Wiley and Sons, New York,1975
5. Edition, American Association of State Highway and Transportation Officials, Washington, D.C., USA, 2008.
6. F. L. Mannering, W. P. Kilareski and S. S. Washburn, Principles of Highway Engineering and Traffic Analysis. Wiley India Pvt. Ltd., New Delhi.
7. H.N. Atkins, Highway Construction and Maintenance, Soils, and Concretes, Reston Publishing Company, Reston VA, 1983.
8. Handbook on Quality Control for Construction of Roads and Runways, IRC, 1988
9. IRC and IS related Codes for Flexible and Rigid Pavements design and Materials.
10. IRC: 37-2012Guidelines for the Design of Flexible Pavements, The Indian Roads Congress, New Delhi, India, 2012.
11. IRC:58-2015Guidelines for the Design of Plain Jointed Rigid Pavements for Highways, The Indian Roads Congress, New Delhi, India, 2015.
12. J. P. Watson, Highway Construction and Maintenance, Longman Scientific and Technical, New York, 1989.
13. Kadiyali and Lal, Principles of highway engineering, Khanna Publishers, Delhi-6
14. Kadiyali L. R. and Lal, N. B., Principles & Practice of Highway Engineering, Khanna Publishers,Delhi.
15. Khanna S.K., Justo C.E.G., Highway Engineering, Nem Chand & Bros., Roorkee.
16. Mallick, R.B. and T. El-Korchi Pavement Engineering – Principles and Practice, CRC Press, Taylor and Francis Group, Florida, USA, 2009.
17. MEPDG-1.Mechanistic-Empirical Pavement Design Guide - A Manual of Practice, Interim
18. MichealSargious Pavement and surfacing for Highway & Airports, Applied science Publishers Limited
19. ParthoChakraborty and Animesh Das, Principles of Transportation Engineering, PHI
20. Paul H. Wright,.Karen K. Dixon, Highway Engineering, John Wiley & Sons, 7th edition, 2004.
21. Peurifoy R. C, and C. J. Shexnaydr, Construction planning. Equipment and methods, , McGraw Hill, 2002 18. The Asphalt Handbook, MS-4, Asphalt Institute, Maryland, 1989
22. Relevant IRC, BIS, AASHTO and PCA Specifications and Guidelines.
23. Sharma &Shrama, Principles and Practice of Highway Engg.
24. Specifications for Hot mix plant, IS:5890-1970andIS:3066-1965,New Delhi.
25. SRC, DSIR, Bituminous Materials in Road Construction, HMSO publication.
26. Tang, Pavement Design
27. Y. H. Huang, Pavement Analysis and Design. Prentice Hall, Englewood Cliffs, New Jersey, USA,1993, ISBN-0-13-655275-7

(b) Open source software and website:

1. IITPAV
2. KENPAVE

Suggested Course Practical List: If any

1. Tutorials based on highway materials and their properties.
2. Problems based on analysis for Flexible and Rigid pavement.
3. Tutorials based on design of Flexible Pavements.
4. Tutorials based on design of Rigid Pavements.
5. Tutorials based on various methods of highway construction.

List of Laboratory/Learning Resources Required:

1. CBR Test.
2. Plate Bearing Test
3. Marshall Stability Test
4. Bitumen Extractor Test
5. Mix Design for BC/DBM

Major Equipment:

1. Marshall Stability
2. CBR Apparatus
3. Viscosity meter

Pavement design Project

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