



Birla Institute of Technology & Science, Pilani
Hyderabad Campus

ACADEMIC UNDERGRADUATE STUDIES DIVISION
SECOND SEMESTER 2023-2024

Course Handout Part II

Date: 23-12-2023

In addition to Part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : CE F244
Course Title : Highway Engineering
Instructor-in-Charge : Sridhar Raju
Lab Instructors : Prasanta Sahu, Akshay Gundla
Instructor : Sridhar Raju

1. SCOPE AND OBJECTIVES OF THE COURSE:

The growth of any country is measured by its transportation facilities through which economic, social, political and strategic developments take place. This course aims at providing a comprehensive insight of various elements of Highway transportation engineering. Topics related to the highway development, characterisation of different materials needed for highway construction, structural and geometric design of highway pavements along with the challenges and possible solutions to the traffic related issues will be covered as a part of this course.

2. Course Outcomes:

At the end of this course, the students will develop:

1. An ability to apply the knowledge of mathematics, science and engineering in the areas of Highway Geometric Design, Pavement Materials, Pavement Analysis and Design, Traffic Engineering and Safety.
2. An ability to design, and conduct experiments to assess the suitability of highway materials like soil, bitumen, aggregates and various bituminous mixtures. Also, the students will develop the ability to interpret the results and assess the suitability of these materials for the construction of highways. They will be able to extend this knowledge in the design of flexible and rigid pavements for varying traffic compositions. They will be



introduced to refer the standards/codes developed by the Indian Roads Congress for the design of Highway Pavements.

3. An ability to evaluate the structural condition of the in-service flexible pavements and design overlays as per the guidelines developed by the Indian Roads congress (IRC).
4. An ability to assess the issues related to road traffic and provide engineering solutions supported with an understanding of road user psychological and behavioural patterns.

Student Learning Outcomes (SLOs) assessed in this course – (a), (b), (c), (e), (f), (g), (h), (j), and (k).

3. Textbooks:

T1. Khanna, S.K., Justo, C. E. G., and Veeraragavan, A., 'Highway Engineering', Nem Chand & Bros. Revised Tenth Edition, 2017

T2. Khanna, S.K, Justo, C. E. G., and Veeraragavan, A, 'Highway Materials and Pavement Testing', Nem Chand & Bros., 2013 (For conducting the Laboratory Experiments)

Reference books

R1. Kadiyali L.R. and Lal N B, Principles and Practices of Highway Engineering; Khanna Publishers, New Delhi, 2023

R2. Papacoastas, C. S. and Prevedouros, Transportation Engineering and Planning, Third Edition; Pearson Education, 2008.

R3. Khisty C J and Lall B Kent; Transportation Engineering: An Introduction, Third Edition; Prentice Hall of India Private Limited, New Delhi, 2002

R4. Kadiyali L R; Traffic Engineering and Transportation Planning; Khanna Publishers, New Delhi; 2003.

R5. Garber, N.J. and Hoel, L.A. Traffic and Highway Engineering, Fourth Edition; Cengage Learning, Stamford, CT, USA, 2010

R6. Partha Chakraborty and Animesh Das, Principles of Transportation Engineering, PHI, 2013



R7. Design Codes: Latest codes of IRC 37, IRC 58, IRC 81, MS 2 manual and other IS, MoRT&H Specifications

R8. Kandhal, Prithvi Singh, Bituminous Road Construction in India, 2019, by PHI, **ISBN:** 978-81-203-5258-2

4. Course Plan:

Lecture No.	Topics to be covered	Learning Objectives	Reference to Text Book / Reference Book	SLO*
1	Introduction to Highway Planning and Development	To Identify the intricacies involved in Highway planning and Development	T1: Chapter-1 & 2	a
I. Highway Material Characterization (Lectures 2 to 12)				
2-15	Testing of aggregate, bitumen and the design of bituminous mixtures.	To test highway construction materials, soil, aggregate, and bitumen. Also, the student will be able to design the bituminous mixtures and assess their suitability in various binding and surface layers of the flexible pavement. The student will also be exposed to new technologies.	T1: Chapters 6 plus relevant IRC Codes	a, b, c, d, e, f
II. Highway Geometric Design (Lectures 13 to 20)				
16	Introduction to Highway Geometric Design	To identify the forces acting on a highway vehicle travelling through a curvilinear section	T1: Chapter-4	a, c
17	Width of Pavement, Formation and Land; Cross Slopes	To get exposed to various basic cross section elements of highways	T1: Chapter-4	a, c



18-19	Stopping Sight Distance, Overtaking Sight Distance and Intermediate Sight distance	To be able to ensure safety gap between the vehicles travelling in the same direction, and in the opposite direction. In addition, to be able to identify the process of overtaking maneuver mathematically to design overtaking zones on highways.	T1: Chapter-4	a, c
20-22	Horizontal Curves, Super elevation, Widening of Pavement	To be able to design elements needed to handle Horizontal Alignment of any highway by understanding the dynamics of vehicular movement and stability of moving vehicle on horizontal highway curves	T1: Chapter-4	a, c
23-25	Gradient, Compensation in Gradient, Summit Curves, Valley Curves	To be able to design elements needed to handle vertical Alignment of any highway with regard to handling the gradients for highway development	T1: Chapter-4	a, c

III. Traffic Engineering (Lectures 26 to 30)

26-27	Basic traffic characteristics - Speed, volume and concentration. Relationship between Flow, Speed and Concentration, Basic definitions of capacity; Level of service (LOS) concept; Factors affecting	To relate the traffic parameters with the road safety while ensuring mobility and accessibility. This topic is being designed to cover requisites like Traffic Characteristics, Highway Capacity and Level of Service, traffic signals,	T1: Chapter 5	a, b
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	capacity & LOS; Volume & Spot Speed Studies, Methods, Interpretations & Analysis, Statistical applications in traffic engineering, Road Safety	parking demand & schemes and accident studies as well as road safety audits.		
28-29	Warrants for signalization, types & design of Isolated Traffic Signal by IRC method, Introduction to signal coordination, Parking and road accidents, Types of Parking Facilities – On-street and off street; Introduction to Parking Inventory, Introduction to road accidents and road safety audits	To relate the traffic parameters with the road safety while ensuring mobility and accessibility. This topic is being designed to cover requisites like Traffic Characteristics, Highway Capacity and Level of Service, traffic signals, parking demand & schemes and road safety audit.	T1: Chapter 5	a, c, e, f, h, i
30	At Grade Intersections, Rotary Islands and Grade separated Interchanges, Case study examples	To be able to learn the intricacies of intersection designs with special emphasis on practical aspects of At Grade, Grade separated intersections and interchanges	PDF Notes Provided during the class	a, c
IV. Highway Pavement Design, Construction and Maintenance (Lectures 31 – 41)				
31-34	<u>Flexible Pavement</u> : Design Factors, IRC 37 Method of flexible pavement design, Introduction to MEPDG flexible pavement design	To be able to design a flexible pavement structure by the end of this chapter	T1: Chapter 7 + IRC Codes	a, c
35-38	<u>Rigid Pavement</u> : General Design Considerations, Critical Load Positions, Wheel Load Stresses, Temperature Stresses, IRC 58 Method of Rigid Pavement Design.	To be able to design a rigid pavement structure by the end of this chapter	T1: Chapter 7 + IRC Codes	a, c

39	Overlay design: Benkelman and FWD methods.	To be able to design an overlay on a flexible pavement structure by the end of this chapter	T1 Chapter 7 + IRC Codes	a, b, c, e
40	Introduction to highway construction activities.	To recognize what happens in the field during the highway construction process	Notes, Web References and Power point slides	a, k

*Student Learning Outcomes (SLOs):

SLOs are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

- (a) An ability to apply knowledge of mathematics, science and engineering
- (b) An ability to design and conduct experiments, as well as to analyze and interpret data
- (c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (d) An ability to function on multidisciplinary teams
- (e) An ability to identify, formulate, and solve engineering problems
- (f) An understanding of professional and ethical responsibility
- (g) An ability to communicate effectively
- (h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (i) A recognition of the need for, and an ability to engage in life-long learning
- (j) A knowledge of contemporary issues
- (k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Highway Material Testing and Traffic Engineering Laboratory component - List of experiments

Expt. No	Cycle	Name of the Experiment	SLOs
E1	1	Aggregate Tests- Physical properties i. Specific gravity, Impact, crushing, Los Angeles Abrasion test	
E2		Aggregate Tests - Chemical Properties ii. Soundness test	
E3		Bitumen Tests- Consistency Tests i. Penetration, softening point, specific gravity	



E4		Bitumen Tests- Rheological Properties ii. Dynamic Viscosity, Kinematic Viscosity, iii. Rotational Viscometer, iv. Dynamic Shear Rheometer	b,c, f,g,k
E5		v. Marshall Mixture Design Sample Preparation vi. Marshall specimen Testing	
E1	2	Fatigue – Indirect Tensile Fatigue Test	
E2		Rutting –Hamburg Wheel Tracking Test	
E3		Spot speed, traffic count at junction and mid-block	
E4		Demonstration of pavement instrumentation	
E5		Demonstration of advanced equipment	

5. Evaluation Scheme:

Component	Duration	Weightage	Date & Time	Nature of Component
Midterm Test	90 Minutes	25%	14/03 - 4.00 - 5.30PM	CB
Laboratory Experiments and related evaluation	Throughout the semester	15%	-	OB
Laboratory Skill Test with Viva	60 Minutes	10%	-	CB
Project presentation (groups of 5)	Throughout the semester	10%	-	OB
Classroom participation	Throughout the semester	10%		OB
Comprehensive Exam	180 Min.	30%	14/05/2023 AN	CB

6. Chamber Consultation Hour:

Wednesday evening 4-6 pm.

7. Make Up Policy:



- Make up requests received on social networking platforms / SMS / WhatsApp will be ignored and no further action is possible. Written makeup requests on the proforma available with the lab staff shall only be used
- Make up will be granted only for genuine reasons and will be considered on a case to case basis. However, prior permission is a must.
- For medical cases, a certificate from the concerned physician from the Medical Centre/hospital must be produced. In addition, copies of the prescription along with the medicine bills should be submitted as a proof. Hostel office / warden / chief warden should certify that they have the information regarding the illness of the makeup applicant. Proforma for medical certificate as well as hostel warden certificate will be uploaded on CMS.
- Made-up medical certificates / other proofs will be seriously considered and will be referred to the disciplinary committee for further necessary action.
- Make-up policy is applicable for Midterm and comprehensive examinations and the weekly lab experiments only. All other components, including laboratory skill tests and Viva, will not have any make-ups.

8. Academic honesty and academic integrity Policy:

Academic honesty and integrity are to be maintained by all students throughout the Semester, and no type of academic dishonesty is acceptable. Students are encouraged to use anti-plagiarism software to check reports before submission.

9. Notices:

Notices, if any, concerning the course will be displayed in the CMS.

Instructor-in-Charge
CE F244

