Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2022-2023

Course Handout Part II

Date: 16-01-2023

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	:	V VINAYAKA RAM
Lab Instructors	:	Md. Ikramullah Khan
Instructor	:	V Vinayaka Ram

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 traffic engineering, highway development and maintenance

2. An ability to design, conduct experiments to assess the suitability of the highway materials like soil, bitumen, aggregates and a variety of bituminous mixtures. Also the students will develop the ability to interpret the results and assess the suitability of these materials for construction of highways and extend this understanding to design flexible and rigid highway pavements for varying traffic compositions as well as soil subgrade and environmental conditions using the standards stipulated by Indian Roads Congress.

3. An ability to evaluate the structural and functional conditions of in-service highway pavements and provide solution in the form of routine maintenance measures or designed overlays using Indian Roads congress guidelines.

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, A and Veeraragavan, A, 'Highway Engineering', Nem Chand & Bros. Revised Tenth Edition, 2014

T2. Khanna, S.K, Justo, A and Veeraragavan, A, 'Highway Materials and Pavement Testing', Nem Chand & Bros., Fifth Edition, 2009 (For Lab Portion)

Reference books

R1. Kadiyali L.R. and Lal N B, Principles and Practices of Highway Engineering; Fourth Edition; Khanna Publishers, New Delhi, 2011

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 Codes

R8. Kandhal, Prithvi Singh, Bituminous Road Construction in India, 2016, 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)**			
2-12	Basic Tests on aggregates and bitumen, Introduction to Modified Bitumen, Bituminous Concrete Mixture Design by Modified Marshall's Method, Introduction to Superpave Mixture Design, Job Mix Formula, Introduction to Warm mix design, Cold mix design, and mixes with RAP materials	To test and evaluate the suitability of highway construction materials namely, soil, aggregates, bitumen, cement. Also the student will acquire the ability of designing the bituminous concrete mixtures and assess their suitability in various bitumen bound layers of flexible pavement structure. The student will also get exposed to the new mix technologies along with recycled mixes	T1: Chapters 6 plus relevant IRC Codes	a, b, c, d, e, f
II.	**Highway Geometric Design (Lectures 13 to 20)**			
13	Introduction to Highway Geometric Design	To identify the forces acting on a highway vehicle travelling through a curvilinear section	T1: Chapter-4	a, c
14	Width of Pavement, Formation and Land; Cross Slopes	To get exposed to various basic cross section elements of highways	T1: Chapter-4	a, c
15-16	Stopping Sight Distance, Overtaking Sight Distance and Intermediate Sight distance	To be able to ensure safety gap between the vehicles travelling in the opposite directions as well as the vehicles travelling in the same 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
17-18	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
19-20	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 21 to 30)**			
21-25	Basic traffic characteristics - Speed, volume and concentration. Relationship between Flow, Speed and Concentration, Basic definitions of capacity; Level of service (LOS) concept; Factors affecting capacity & LOS; Volume & Spot Speed Studies, Methods, Interpretations & Analysis, Statistical applications in traffic engineering, Road Safety	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 accident studies as well as road safety audits.	T1: Chapter 5	a, b

26-28	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
29-30	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)**			
31-33	Flexible Pavement: 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
34-36	Rigid Pavement: General Design Considerations, Critical Load Positions, Wheel Load Stresses, Temperature Stresses, IRC 58 Method of Rigid Pavement Design, Introduction to MEPDG 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
37- 39	Overlay design: Benkelman and FWD methods, Introduction to Design of Thin White Topping (TWT) overlays	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 the stages of highway construction activities.	To recognize what happens in the field during the highway construction process	Notes, Web References and Power point slides	a, k
41	Introduction to pavement failures and maintenance activities	To be able to understand the importance of identifying the pavement failures and the need of maintenance activities	IRC codes and web sources	a, k
V.	**Introduction to advanced topics**			
42	Introduction to Intelligent Transportation Systems (ITS)	To get exposed to the World of Multi-disciplinary system of Intelligent Transportation Systems (ITS)	Notes, Web References and Power point slides	a, d, 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	Turns	SLOs
E1	1	Determination of Abrasion and Crushing value of Aggregates	1	b,c, f,g,k
E2		Determination of Flakiness and Elongation Index of Aggregates, determine Stripping Value of the Aggregates with and without anti-stripping agents	1	
E3		To find the Specific Gravity and Impact Value of Aggregates	1	
E4		Spot Speed Study and traffic noise studies	1	
E5		Parking Inventory Study	1	
E1	2	To find Penetration, Softening Point and Specific Gravity of Bitumen samples	1	
E2		Determining ductility of bitumen and Elastic Recovery of a given modified bitumen	1	
E3		Preparation and Testing of Marshall's Samples for Mixture Design	1	
E4		Spot test and viscosity of bitumen using Brookfield rotational viscometer	1	
E5		Demonstration of equipment like MERLENE, Bump Integrator, Benkelman Beam, Straight Edge, RTFOT	1	

5. Evaluation Scheme:

Component	Duration	Weightage	Date & Time	Nature of Component
Midterm Test	90 Minutes	25%	15/03 9.30 - 11.00AM	CB
Laboratory Experiments and related evaluation	Throughout the semester	15%	-	OB
Laboratory Skill Test with Viva	60 Min.	10%	-	CB
Take-home Assignments	Throughout the semester	10%	-	OB
In-class assessments	Throughout the semester	10%		OB
Comprehensive Exam	180 Min.	30%	12/05 FN	CB

6. Chamber Consultation Hour:

To be announced during the first class

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 & Comprehensive examinations and the weekly lab experiments only. All other components, including laboratory skill test and Viva, will not have any make-ups.

8. Academic honesty and academic integrity Policy:

Academic honesty and academic integrity are to be maintained by all of the students throughout the Semester and no type of academic dishonesty is acceptable.

9. Notices:

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

Instructor-in-Charge
CE F244