

## B.Tech. DEGREE EXAMINATION, JUNE 2023

Seventh Semester

### 18CEE401T - PAVEMENT ANALYSIS AND DESIGN

(For the candidates admitted during the academic year 2018-2019 to 2021-2022)

**Note:**

- i. **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40 minutes.
- ii. **Part - B** and **Part - C** should be answered in answer booklet.

**Time: 3 Hours**

**Max. Marks: 100**

**Part - A (20 × 1 Marks = 20 Marks)**

Answer **All** Questions

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|---|---|---|---|
| <p>1. The increasing order of modulus of layers considered in the stress/strain analysis of layered structure is</p> <p>(A) Esubgrade, Ebase, Ehma (B) Ehma, Esubgrade, Ebase</p> <p>(C) Esubgrade, Ehma, Ebase (D) Ebase, Esubgrade, Ehma</p>  | 1 | 1 | 1 |
| <p>2. The contact pressure used for the determination of stress and strain in the pavement is _____ the tyre pressure of the vehicle</p> <p>(A) equal to (B) greater than</p> <p>(C) less than (D) twice</p>  | 1 | 1 | 1 |
| <p>3. For a wheel load of 20kN and tyre pressure of 560 kPa, the contact radius of the load is</p> <p>(A) 106.6 mm (B) 106.6 cm</p> <p>(C) 213.2 mm (D) 213.2 cm</p>  | 1 | 3 | 1 |
| <p>4. The vertical compressive strain at the top and 50 mm below the subgrade layer is 150 and 130 microstrain respectively. The horizontal tensile strain at the top and bottom of HMA layer is 220 and 200 microstrain. The strain that induce rutting in the subgrade layer is</p> <p>(A) 130 microstrain (B) 150 microstrain</p> <p>(C) 220 microstrain (D) 200 microstrain</p> | 1 | 2 | 1 |
| <p>5. Which of the below material in the pavement exhibit time dependent behaviour on loading</p> <p>(A) Bitumen (B) Aggregate</p> <p>(C) Soil (D) Cement</p>   | 1 | 2 | 2 |
| <p>6. Which of the below is the Maxwell model behavior</p> <p>(A) Creep increases at the steady rate (B) Creep increases exponentially</p> <p>(C) Creep decreases at the steady rate (D) Creep decreases exponentially</p>  | 1 | 2 | 2 |
| <p>7. Select the property that differentiate viscoelastic material from elastic material?</p> <p>(A) Temperature dependent (B) Time independent characteristic</p> <p>(C) Time dependent characteristic (D) Temperature independent characteristic</p>  | 1 | 1 | 2 |
| <p>8. The phase angle of the ideal viscous material is</p> <p>(A) 90 degree (B) 0 degree</p> <p>(C) 180 degree (D) 45 degree</p>  | 1 | 2 | 2 |
| <p>9. Tie bars are provided along _____</p> <p>(A) Transverse joint to transfer load (B) Longitudinal joint to transfer load</p> <p>(C) Longitudinal joint to hold the slab in position (D) Transverse joint to hold the slab in position</p>   | 1 | 1 | 5 |

10. High temperature in the performance grading system represents (A) Extreme temperature of rutting failure (C) Extreme temperature of fatigue damage	(B) Rutting initiation temperature (D) Fatigue damage initiation temperature	1	2	3
11. The storage modulus and the loss of modulus of the binder is 60 and 60 MPa. Its phase angle is (A) 0 degree (C) 90 degree	(B) 45 degree (D) 60 degree	1	3	3
12. Which of the binder have higher viscosity at any given conditions? (A) VG10 (C) VG20	(B) VG30 (D) VG40	1	1	3
13. The penetration of bitumen is generally measured at (A) 60 °C (C) 10 °C	(B) 25 °C (D) 40 °C	1	1	3
14. Fatigue damage in the bituminous pavement occurs due to (A) Tensile strain at the bottom of the asphalt layer (C) Compressive strain at the bottom of the asphalt layer	(B) Tensile strain at the top of the subgrade (D) Compressive strain at the top of the subgrade	1	1	4
15. The CBR of the subgrade soil is found to be 5%. Its resilient modulus value can be taken as (A) 5 MPa (C) 5 kPa	(B) 50 MPa (D) 50 kPa	1	3	4
16. Which of the below layer is a non-structural layer (A) Subgrade layer (C) SAMI	(B) Granular sub-base layer (D) Cement treated base	1	2	4
17. A front axle of truck of single axle single wheel weighs 65 kN and rear axle of single axle dual wheel weighs 80 kN. What is the vehicle damage factor? (A) 4 (C) 2	(B) 3 (D) 1	1	3	4
18. International roughness index is defined as (A) Deflection in the pavement (C) Percentage of cracked area	(B) Difference in surface level for unit horizontal distance (D) Difference in surface level of road	1	1	5
19. Falling weight deflectometer directly measures (A) Deflection magnitude and shape (C) Modulus of the material	(B) Wheel load (D) Tyre pressure	1	1	5
20. The vertical strain at the layer interface of two layered structural analysis is assumed to be (A) a minimum value of two layers (C) zero	(B) a maximum value of two layers (D) a continuous function	1	1	5

**Part - B (5 × 4 Marks = 20 Marks)**

Answer any 5 Questions

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21. Narrate all the assumptions made in the stress-strain analysis of layered structure	4	2	1
22. Sketch all the axle configuration of the vehicle and explain how these axle configuration is converted to standard axle load	4	3	1

23. Sketch the typical stress relaxation behaviour of the viscoelastic fluid and solid material and explain its salient points	4	3	2
24. Derive the constitutive equation of the Maxwell model	4	2	2
25. Define IRI. Explain how IRI of the existing pavement is measured	4	2	5
26. Differentiate rutting in the bituminous mixture and pavement rutting highlighting the critical factors that governs it.	4	4	3
27. Sketch the layered structure and state the function of each layers	4	2	4

**Part - C (5 × 12 Marks = 60 Marks)**

Answer All Questions

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28. (a) A homogeneous half-space subjected to circular load with a loaded diameter of 250mm and a pressure of 350 kPa. The material has an elastic modulus of 70 MPa and Poisson ratio of 0.5. Determine the vertical stress, strain, and deflection at point located at 125 mm below the center of loading. (OR) (b) List and explain various traffic factors considered in the design of flexible pavement	12	2	1
29. (a) Explain with neat sketch, the response of viscoelastic material to i) Constant load ii) Constant deformation iii) Sinusoidal load (OR) (b) Derive the constitutive equation of Kelvin model and explain its creep-recovery behaviour and stress relaxation behaviour	12	3	2
30. (a) Write in detail, the specifications that are considered for the selection of unmodified and modified bitumen for any highway project (OR) (b) Define resilient modulus. Explain how the resilient modulus of granular material can be determined.	12	2	3
31. (a) Compute the design traffic for a two-lane two-way road using IRC method using the following input data: Initial traffic in the year of completion of construction is 5000CVPD (two-way), traffic growth rate per annum is 6.2 %, design life period is 20 years and vehicle damage factor is 5.2 (OR) (b) The maximum tensile strain at the bottom of the HMA layer and the maximum compressive strain at the top of the subgrade for the given layered structure was found to be 150 and 350microstrain. What is the number of standard axle repetitions the pavement can withstand before it fails in rutting? Use 80% reliability equation of IRC:37-2018. What will be the critical life when the design reliability is 90%.	12	4	4
32. (a) Explain the method of measurement of pavement deflection using i) Falling Weight Deflectometer ii) Benkleman deflectometer (OR) (b) List the possible distresses in rigid pavement. Mention its causes and suggest the remedial measure to rectify the distress.	12	2	5

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