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B.Tech DEGREE EXAMINATION, NOVEMBER 2023

Seventh Semester

18CEE401T - PAVEMENT ANALYSIS AND DESIGN

(For the candidates admitted during the academic year (2020-2021 & 2021-20222))

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 40th minute.

ii. **Part - B** and **Part - C** should be answered in answer booklet.

Time: 3 Hours **Max. Marks: 100**

PART - A (20 × 1 = 20 Marks)

Answer **all** Questions

		Marks	BL	CO
1.	Which of the below strain induces crack in the pavement (A) Vertical strain in soil layer (B) Tensile strain in asphalt layer (C) Tensile strain in base layer (D) Vertical strain in sub base layer	1	2	1
2.	The vertical, tangential and radial stress at a point in the pavement layer is 100, 20 and 20 kPa respectively. If the Modulus of elasticity and Poisson's ratio is 100 MPa and 0.5, respectively the value of vertical strain is (A) 0.0080 (B) 0.0008 (C) 0.0160 (D) 0.0016	1	4	1
3.	If the linearity in the elastic layered theory analysis is not satisfied, then (A) The modulus of the layer will be independent of stress (B) The modulus of the layer will be stress dependent (C) The thickness of the layer will be constant (D) The thickness of the layer decreases	1	3	1
4.	A wheel with a tire pressure of 560 kPa and a wheel load of 20 kN is expected to have a contact area of (A) 35714 square mm with a circular contact (B) 35714 square mm with a square contact (C) 35.714 square mm with a circular contact (D) 35.714 square mm with a elliptical contact	1	3	4
5.	When the load to the flexible pavement layer is applied through the flexible tire, which of the following condition is true (A) The pressure distributed is maximum at the center and minimum at the end of contact (B) Flexible tire distributes uniform load (pressure) with the maximum deflection at the center of contact area (C) The deflection is uniform under the contact load (D) Flexible tire distributes uniform load (pressure) and uniform deflection in the contact area	1	2	1
6.	In any material, if the strain increases with time when subjected to constant load, the material is said to (A) Creep (B) Relax (C) Recover (D) Decompose	1	2	2

7. Which of the below statement best describes the characteristic of the viscoelastic material 1 1 2

(A) The material exhibits time dependent response with complete energy dissipation
(B) The material exhibits time independent response with zero energy dissipation
(C) The stress in the material is proportional to strain rate
(D) The material exhibits time dependent behavior and dissipates energy partially

8. The loss modulus and the storage modulus of the material are equal. What is the lag between stress and strain? 1 2 3

(A) 90 degree
(B) 45 degree
(C) 0 degree
(D) 30 degree

9. 1 3 2

Which of the below modulus equation captures the relaxation behavior of the viscoelastic material. Here, E represents modulus, σ represents stress, ϵ represents strain, t denotes time, ϵ_0 and σ_0 are the constant strain and stress to which the material is subjected to.

(A) $E(t) = \frac{\sigma(t)}{\epsilon_0}$

(B) $E(t) = \frac{\epsilon(t)}{\sigma_0}$

(C) $E(t) = \frac{\epsilon_0}{\sigma(t)}$

(D) $E(t) = \frac{\sigma_0}{\epsilon(t)}$

10. Which of the below equation represents the constitutive relation of the Newtonian material 1 2 2

(A) Stress is proportional to strain
(B) Stress is proportional to strain rate
(C) Stress is proportional to inverse of strain
(D) Stress is proportional to inverse of strain rate

11. Select the test that is exclusively used in grading of modified bitumen 1 1 3

(A) Viscosity
(B) Penetration
(C) Multiple creep and recovery
(D) Stress relaxation

12. Which of the following is the hardest grade of modified bitumen 1 3 3

(A) PMB 64-10
(B) PMB 70-10
(C) PMB 76-10
(D) PMB 82-10

13. Bitumen with creep compliance of less than 0.5 kPa^{-1} is used in the location where the traffic is 1 2 3

(A) slow moving
(B) fast moving
(C) Very slow moving or standing traffic
(D) very fast moving

14. As the bitumen in the pavement ages, it 1 2 4

(A) Viscosity decreases and modulus increases
(B) Viscosity and modulus increases
(C) Viscosity and modulus decreases
(D) Viscosity increases and modulus decreases

15. A front axle of truck of single axle single wheel weighs 64 kN and rear axle of single axle dual wheel weighs 80 kN. What is the vehicle damage factor? 1 3 4

(A) 2
(B) 1
(C) 3
(D) 2.5

16.	Select the correct statement (A) Crack relief layer are provided about the base layer with RAP and emulsion (B) Crack relief layer are provided above the stiff sub grade layer (C) Crake relief layer is provided in between bituminous layer and the granular layer (D) Crake relief layer is provided about the cement treated base layer	1	2	4
17.	A mixture of well-graded fine aggregate, filler, and emulsion forms (A) Fog seal (B) Bituminous concrete (C) Slurry seal (D) Stone mastic asphalt	1	1	5
18.	The thickness of the existing pavement for overlay design is estimated using (A) Percentage of cracked surface (B) IRI (C) Friction (D) Deflection	1	1	5
19.	Which of the below statement is a correct statement that is related to the falling weight deflectometer (A) It is the non destructive test used for measuring the deflection of the pavement (B) It is the non destructive test that directly records the Modulus of the pavement layers (C) It is the destructive test used for measuring the deflection of the pavement (D) It is the destructive test that directly records the modulus of the pavement layers	1	2	5
20.	Fault in rigid pavement represents (A) Transverse crack in the pavement (B) Insufficient thickness (C) The difference in level between two slab (D) Longitudinal crack in the pavement	1	1	5

PART - B (5 × 4 = 20 Marks)

Answer **any 5** Questions

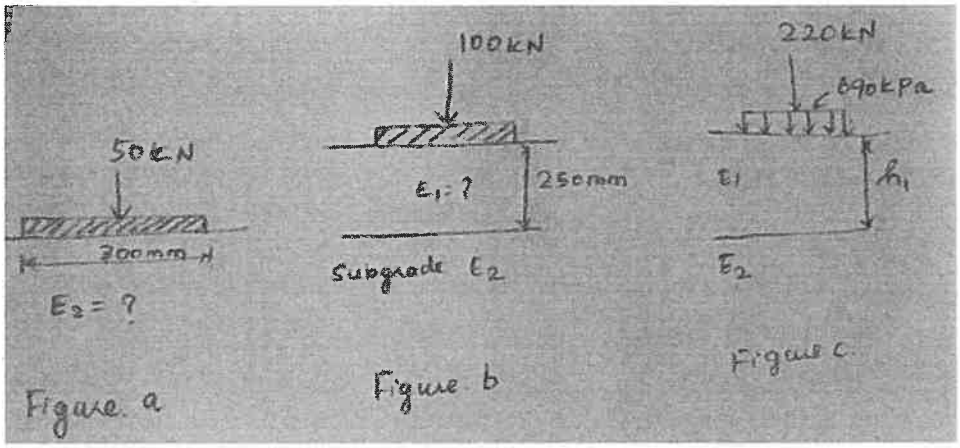
		Marks	BL	CO
21.	Discuss the contact pressure and the deflection pattern when the layered structure is loading using flexible and rigid plate	4	3	1
22.	State any two important assumptions in the elastic-layered analysis and explain the consequence if the assumption fails	4	4	1
23.	Derive the constitutive relation of the Maxwell model	4	2	2
24.	Explain time-temperature superposition principle and state how it is used in the pavement design	4	3	3
25.	Differentiate between the dynamic modulus and the resilient modulus of the bituminous mixture	4	2	3
26.	Draw a few typical configurations of axles and wheels of vehicles. Explain why tandem axles are preferred to single axles for truckload transfer on to the pavement surface	4	3	4
27.	How does flexible pavement undergo plastic deformation due to wheel load? Explain with a proper sketch.	4	2	5

PART - C (5 × 12 = 60 Marks)

Answer **all** Questions

		Marks	BL	CO

28. (a) A plate bearing test using a 300 mm diameter rigid plate is made on a sub grade, as shown in Figure a. The total load required to cause settlement by 6 mm is 50 kN. A gravel base of 250 mm thick is place on the sub grade and a plate bearing test is made on the top of the base course, as shown in Figure b. The total load required to cause settlement by 6 mm is 100 kN. Assuming a Poisson ratio of 0.5, determine the thickness of base course require to sustain a 220 kN tire exerting a contact pressure of 690 kPa over a circular area as shown in Figure c and yet maintain a deflection of not more than 6 mm. 12 4 1



(OR)

(b) In a uniform half-space, under the influence of a circular load with a loaded diameter of 200 mm and a pressure of 425 kPa, where the material has an elastic modulus of 80 MPa and Poisson's ratio of 0.5, calculate the vertical stress, strain, and deflection at a point situated 60 mm below the center of the load.

29. (a) Explain with neat sketch, the creep and recovery response and stress relaxation response of viscoelastic material. 12 3 2

(OR)

(b) Derive the constitutive relation of the viscoelastic Kelvin model and explain how the model will behave under constant stress and recovery

30. (a) How is modified bitumen graded? Explain in detail the process involved in grading modified bitumen. 12 2 3

(OR)

(b) What is bitumen emulsion? State how bitumen emulsions are classified and explain the behavior of each types of emulsion.

31. (a) What are the critical strains considered in the design of M-E method of pavement design. Explain in detail IRC method of flexible pavement design. Mention the inadequacy and suggest the points for design improvement in IRC37 12 3 4

(OR)

(b) i) Explain the significance of traffic growth rate and lane distribution factor in the design of flexible pavement.

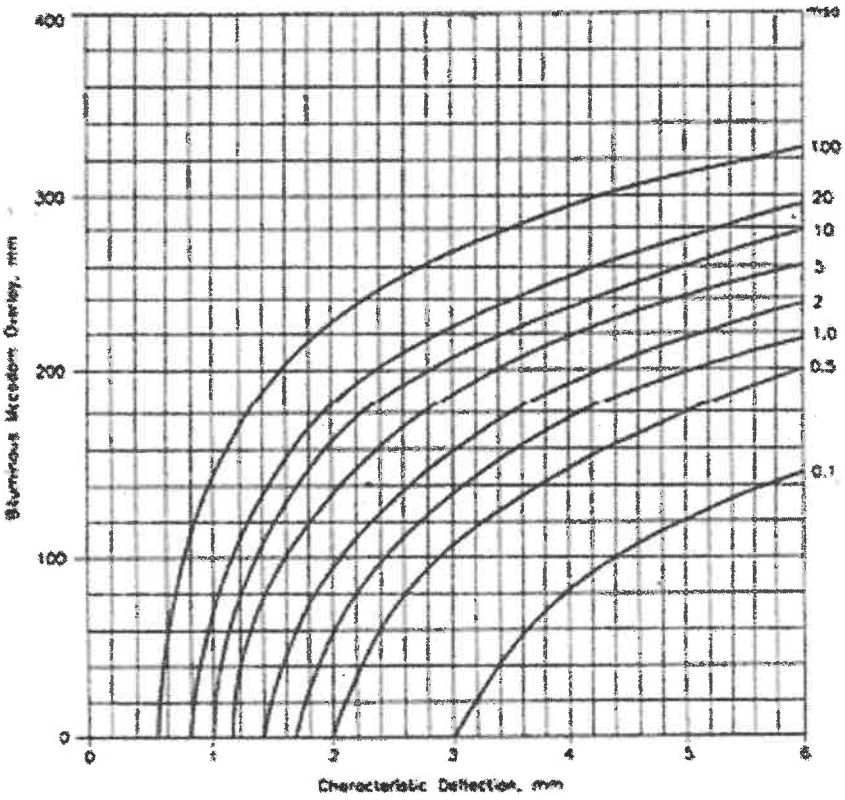
ii) The following data is obtained from the axle load survey conducted for 3 days. Determine the equivalent number of standard axle loads of 80 kN repetitions per year.

Axle Load (kN)	30-40	40-50	50-60	60-70	70-80	80-90
Repetitions	54	65	56	78	103	98
Axle Load (kN)	90-100	100-110	110-120	120-130	130-140	140-150
Repetitions	110	98	78	87	67	65

32. (a) What are the various types of failures in flexible pavement. Explain the causes and give remedial measures. 12 2 5

(OR)

(b)) Explain how the deflection is measured using Benkleman Beam test procedure.
The following are the 12 deflections in mm measured using Benkleman beam.
1.46, 1.52, 1.56, 1.76, 1.96, 1.75, 1.68, 1.74, 1.96, 1.42, 1.56, 1.62
All the observations were carried out at the temperature of 43 °C. Calculate the overlay thickness for 100 msa. Use sub grade moisture correction as 2 and the following chart.



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