27. a. Derive the constitutive equation of kelvin model and sketch its creep and recovery behaviour. | 10 | 3 | 2 | 1

(OR)

b. When the viscoelastic material is subjected to oscillatory shear in strain-controlled mode, explain the stress response in the material. Clearly define and explain the viscoelastic characteristic functions used. | 10 | 3 | 2 | 1

28. a. Write the experimental procedure to measure the resilient modulus of soil/ granular material. How is CBR of soil related to resilient modulus? | 10 | 2 | 3 | 1

(OR)

b. What is bitumen emulsion? Write the step by step process involved in the production of bitumen emulsion. Also clearly explain the emulsion braking process. | 10 | 2 | 3 | 1

29. a. 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. | 10 | 3 | 4 | 1

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

(OR)

b. Explain in detail on the design criteria used in the design of flexible pavement with cement treated base layer. | 10 | 2 | 4 | 1

30. a. List the possible distresses in flexible pavement. Mention it causes and suggest the remedial measures to rectify the distress. | 10 | 2 | 5 | 1

(OR)

b. What is internation roughness index? How is it measured? | 5 | 2 | 5 | 1

ii. Explain how the pavement deflection is measured using Benkelman beam. | 5 | 2 | 5 | 1

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Reg. No.														

B.Tech. DEGREE EXAMINATION, NOVEMBER 2022
Sixth/ Seventh Semester

18CEE401T – PAVEMENT ANALYSIS AND DESIGN

(For the candidates admitted from the academic year 2018-2019 to 2019-2020)
(Use of IRC 37, IS 73, IS 15462 and design charts are permitted)

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** should be answered in answer booklet.

Time: 2½ Hours Max. Marks: 75

PART – A (25 × 1 = 25 Marks) | Marks | BL | CO | PO
Answer **ALL** Questions

1. Burmister's pavement analysis is for _____ layered system. | 1 | 1 | 1 | 1
(A) Single (B) Two
(C) Three (D) Four

2. The surface deflection of the single layered structure is given by _____, where q is contact pressure a is contact radius, E is modulus and γ is Poisson's ratio. | 1 | 2 | 1 | 1
(A) $\frac{2qa}{E}(1+\gamma^2)$ (B) $\frac{2qE}{a}(1+\gamma^2)$
(C) $\frac{2qa}{E^2}(1-\gamma^2)$ (D) $\frac{2qa}{E^2}(1+\gamma^2)$

3. Which of the below stress will be maximum due to application of wheel load? | 1 | 2 | 1 | 1
(A) Shear stress (σ_{rz}) (B) Normal stress (σ_{rr})
(C) Vertical stress (σ_{zz}) (D) Normal stress $(\sigma_{\theta\theta})$

4. Which of the below layer is considered as infinite in depth for stress-strain analysis of pavement? | 1 | 1 | 1 | 1
(A) Surface (B) Base
(C) Subbase (D) Subgrade

5. The Poisson's ratio of bituminous concrete layer is _____. | 1 | 1 | 1 | 1
(A) 0.15 (B) 0.35
(C) 0.50 (D) 0.20

6. The increasing order of energy dissipation in various material is | 1 | 2 | 2 | 1
(A) Elastic, viscous and viscoelastic (B) Elastic, viscoelastic and viscous
(C) Viscous elastic and viscoelastic (D) Viscous, viscoelastic and elastic

7. Permanent deformation in the viscoelastic material leads to | 1 | 2 | 2 | 1
(A) Fatigue cracking in the pavement (B) Shear failure
(C) Pothole formation (D) Rutting in the pavement

8. Phase lag in Newtonian material is — 1 1 2 1
(A) 0° (B) 90°
(C) 45° (D) 180°

9. Which of the below equation more suits for bituminous material? — 1 2 2 1
(A) $\sigma = E\varepsilon$ (B) $\sigma = \mu\dot{\varepsilon}$
(C) $\dot{\varepsilon} = \frac{\dot{\sigma}}{E} + \frac{\sigma}{\mu}$ (D) $\varepsilon = E\sigma$

10. The stress strain plot of viscoelastic material due to sinusoidal shearing is — 1 2 2 1
(A) Circular in shape (B) Straight line
(C) Parabolic (D) Elliptical

11. The penetration of the bitumen is measured at — 1 1 3 1
(A) 25°C (B) 10°C
(C) 65°C (D) 60°C

12. Flow number is used to characterize _____ of bituminous mixture. — 1 1 3 1
(A) Rutting (B) Fatigue damage
(C) IRI (D) Corrugation

13. Which of the below test is used in fatigue life determination of bituminous mixture? — 1 2 3 1
(A) Four-point beam bending test (B) Creep test
(C) Stress-relaxation test (D) Creep and recovery test

14. Select the specification of 16 mm nominal size aggregate — 1 1 3 1
(A) 100 to 85% passing in 20 mm sieve (B) 100 to 85% retained in 16mm sieve
(C) 100 to 85% passing in 16 mm sieve (D) 85% retained in 16 mm sieve

15. Bitumen as per BIS specification are graded based on — 1 1 3 1
(A) Viscosity (B) Dynamic modulus
(C) Resilient modulus (D) Penetration

16. Effective CBR is the — 1 1 4 1
(A) Average CBR of compacted and natural soil
(B) Maximum CBR of compacted and natural soil
(C) Minimum CBR of compacted and natural soil
(D) Equivalent CBR that causes same deformation with compacted and natural soil layer

17. The tensile stress at the bottom of cement treated base layer is 0.70 MPa. If the modulus of rapture 1.4 MPa, what is the fatigue life of the layer. — 1 1 4 1
(A) 9.57 E5 (B) 5.26 E5
(C) 2.12 E6 (D) 3.86 E6

18. The contact pressure considered for the design of cement treated sub base is _____. — 1 1 4 1
(A) 800 MPa (B) 0.800 MPa
(C) 560 MPa (D) 0.560 MPa

19. Front axle of the vehicle is single axle with single wheel weighing 65 kN and rear axle is single axle duel wheel weighing 80 kN. What is the vehicle damage factor? — 1 2 4 1
(A) 1 (B) 4
(C) 2 (D) 3

20. The standard axle load considered for the design of flexible pavement is — 1 2 4 1
(A) 65 kN, single axle single wheel (B) 148 kN, tandem axle
(C) 224 kN, tridem axle (D) 80 kN, single axle dual wheel

21. The possible causes for bleeding in asphalt layer are (is) — 1 1 5 1
(A) Excess bitumen and low air voids (B) Higher air voids
(C) Moisture in the pavement (D) Excess loading

22. A mixture of well graded fine aggregate, filler and emulsion forms — 1 1 5 1
(A) Fog seal (B) Bituminous concrete
(C) Slurry seal (D) Stone mastic asphalt

23. IRI is expressed as — 1 1 5 1
(A) Deflection in the pavement (B) Difference in surface level for unit horizontal distance
(C) Percentage of cracked area (D) Difference in surface level of road

24. Dowel bars are provided to — 1 1 5 1
(A) Load transfer (B) Transfer load and hold slab in position
(C) Hold the slab together (D) Resist moisture infiltration

25. Reflection crack occurs in — 1 1 5 1
(A) Rigid pavement (B) Rigid overlay
(C) Subgrade layer (D) Flexible overlay over rigid pavement

PART – B (5 × 10 = 50 Marks) — Marks BL CO PO
Answer **ALL** Questions

26. a. Narrate the step by step process involved in the stress strain analysis of multilayered pavement. — 10 2 1 1

(OR)

b. A homogenous half-space is subjected to a circular load of 300 mm in diameter having contact pressure of 400 kPa. The half-space has elastic modulus of 75MPa and Poisson's ratio 0.35. Determine all the components of stress, strain and deflection at point that is exactly at the center load and 200 mm below the surface. (Please note Poisson's ratio is not 0.5 and hence you cannot use the charts) — 10 3 1 1