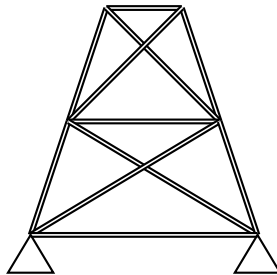


GATE
CE - 2017

EE24BTECH11061 - Rohith Sai

SINGLE CORRECT 2 MARKS EACH

- 1) The solution of the equation $\frac{dQ}{dt} + Q = 1$ with $Q = 0$ at $t = 0$ is
- a) $Q(t) = e^{-t} - 1$
- b) $Q(t) = 1 + e^{-t}$
- c) $Q(t) = 1 - e^t$
- d) $Q(t) = 1 - e^{-t}$
- 2) Consider the matrix $\begin{pmatrix} 5 & -1 \\ 4 & 1 \end{pmatrix}$. Which of the following statements is TRUE for the eigenvalues and eigenvectors of this matrix?
- a) Eigenvalue 3 has a multiplicity of 2, and only one independent eigenvector exists.
- b) Eigenvalue 3 has a multiplicity of 2, and two independent eigenvectors exist.
- c) Eigenvalue 3 has a multiplicity of 2, and no independent eigenvector exists.
- d) Eigenvalues are 3 and -3, and two independent eigenvectors exist.
- 3) A planar truss tower structure is shown in the figure



Consider the following statements about the external and internal determinacies of the truss.

- (P) Externally Determinate
(Q) External Static Indeterminacy = 1
(R) External Static Indeterminacy = 2
(S) Internally Determinate
(T) Internal Static Indeterminacy = 1
(U) Internal Static Indeterminacy = 2
Which one of the following options is correct?

- a) P-False; Q-True; R-False; S-False; T-False; U-True c) P-False; Q-False; R-True; S-False; T-False; U-True
- b) P-False; Q-True; R-False; S-False; T-True; U-False d) P-True; Q-True; R-False; S-True; T-False; U-True

4) Group I contains three broad classes of irrigation supply canal outlets. Group II presents hydraulic performance attributes.

Group I	Group II
P. Non-modular outlet	1. Outlet discharge depends on the water levels in both the supply canal as well as the receiving water course
Q. Semi-modular outlet	2. Outlet discharge is fixed and is independent of the water levels in both the supply canal as well as the receiving water course
R. Modular outlet	3. Outlet discharge depends only on the water level in the supply canal

- a) P-1; Q-2; R-3 c) P-2; Q-3; R-1
- b) P-3; Q-1; R-2 d) P-1; Q-3; R-2

5) A 1 m wide rectangular channel has a bed slope of 0.0016 and the Manning's roughness coefficient is 0.04. Uniform flow takes place in the channel at a flow depth of 0.5 m. At a particular section, gradually varied flow (GVF) is observed and the flow depth is measured as 0.6 m. The GVF profile at that section is classified as

- a) S_1 c) M_1
- b) S_2 d) M_2

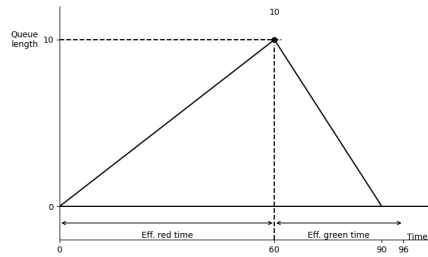
6) The following observations are made while testing aggregate for its suitability in pavement construction:

- Mass of oven-dry aggregate in air = 1000 g
- Mass of saturated surface-dry aggregate in air = 1025 g
- Mass of saturated surface-dry aggregate under water = 625 g

Based on the above observations, the correct statement is

- a) bulk specific gravity of aggregate = 2.5 and water absorption = 2.5% c) apparent specific gravity of aggregate = 2.5 and water absorption = 2.5%
- b) bulk specific gravity of aggregate = 2.5 and water absorption = 2.4% d) apparent specific gravity of aggregate = 2.5 and water absorption = 2.4%

7) The queue length (in number of vehicles) versus time (in seconds) plot for an approach to a signalized intersection with the cycle length of 96 seconds is shown



in the figure (not drawn to scale).

At time $t = 0$, the light has just turned red. The effective green time is 36 seconds, during which vehicles discharge at the saturation flow rate, s (in vph). Vehicles arrive at a uniform rate, v (in vph), throughout the cycle. Which one of the following statements is TRUE?

- a) $v = 600$ vph, and for this cycle, the average stopped delay per vehicle = 30 seconds
- b) $s = 1800$ vph, and for this cycle, the average stopped delay per vehicle = 28.125 seconds
- c) $v = 600$ vph, and for this cycle, the average stopped delay per vehicle = 45 seconds
- d) $s = 1200$ vph, and for this cycle, the average stopped delay per vehicle = 28.125 seconds

8) The radius of a horizontal circular curve on a highway is 120 m. The design speed is 60 km/hour, and the design coefficient of lateral friction between the tyre and the road surface is 0.15. The estimated value of superelevation required (if full lateral friction is assumed to develop), and the value of coefficient of friction needed (if no superelevation is provided) will, respectively, be

- a) $\frac{1}{11.6}$ and 0.10
- b) $\frac{1}{10.5}$ and 0.37
- c) $\frac{1}{11.6}$ and 0.24
- d) $\frac{1}{12.9}$ and 0.24

9) The observed bearings of a traverse are given below:

Line	Bearing	Line	Bearing
PQ	$46^\circ 15'$	QP	$226^\circ 15'$
QR	$108^\circ 15'$	RQ	$286^\circ 15'$
RS	$201^\circ 30'$	SR	$20^\circ 30'$
ST	$321^\circ 45'$	TS	$141^\circ 45'$

The station(s) most likely to be affected by the local attraction is/are

- a) only R
b) only S

- c) R and S
d) P and Q

- 10) The laboratory tests on a soil sample yields the following results: natural moisture content = 18%, liquid limit = 60%, plastic limit = 25%, percentage of clay sized fraction = 25%.

The liquidity index and activity (as per the expression proposed by Skempton) of the soil, respectively, are

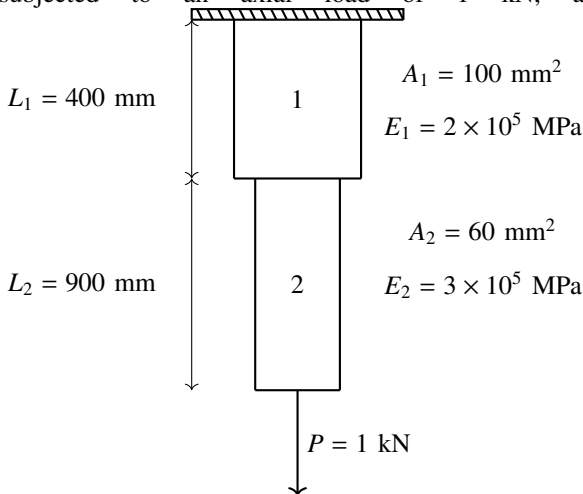
- a) -0.2 and 1.4
b) 0.2 and 1.4

- c) -1.2 and 0.714
d) 1.2 and 0.714

- 11) Consider the equation $\frac{du}{dt} = 3t^2 + 1$ with $u = 0$ at $t = 0$. This is numerically solved by using the forward Euler method with a step size, $\delta t = 2$. The absolute error in the solution at the end of the first time step is _____.

- 12) A pre-tensioned rectangular concrete beam 150 mm wide and 300 mm depth is prestressed with three straight tendons, each having a cross-sectional area of 50 mm^2 , to an initial stress of 1200 N/mm^2 . The tendons are located at 100 mm from the soffit of the beam. If the modular ratio is 6, the loss of prestressing force (in kN, up to one decimal place) due to the elastic deformation of concrete only is _____

- 13) Consider the stepped bar made with a linear elastic material and subjected to an axial load of 1 kN, as shown in the figure.



Segments 1 and 2 have cross-sectional area of 100 mm^2 and 60 mm^2 , Young's modulus of $2 \times 10^5 \text{ Mpa}$ and $3 \times 10^5 \text{ MPa}$, and length of 400 mm and 900 mm, respectively. The strain energy (in N-mm, up to one decimal place) in the bar due to the axial load is _____