GATE Civil Engineering Question Paper year 2000

SECTION A (75 Marks)

1. This question consists of 27 (Twenty Seven) multiple-choice type sub-questions each carrying one mark. The answers to the multiple choice questions MUST be written only in the boxes corresponding to the question number by writing A, B, C or D in the answer book. (27 x 1 = 27)

1.1. If A, B, C are square matrices of the same order, (ABC) -l is equal to

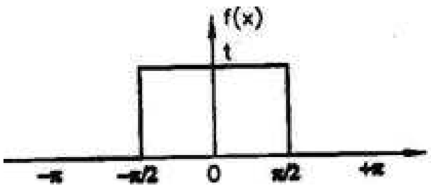
- C -l A -1 B -1
- C -l B -1 A -1
- A -1 B -1 C -l
- A -1 C -l B -1

1.2. The following integral lim a ® ¥ $-\int_1^a x^{-4} dx$

(a) Diverges (b) Converges to $\frac{1}{3}$

(c) Converges to $-\frac{1}{a^3}$ (d) Converges to 0

1.3. A function with a period 2 is shown below



The Fourier series for this function is given by

(a) $f(x) = \frac{1}{2} + \sum_{n=1}^{\infty} \frac{2}{n\pi} \sin\frac{n\pi}{2} \cos nx$.

(b) $f(x) = \sum_{n=1}^{\infty} \frac{2}{n\pi} \sin\frac{n\pi}{2} \cos nx$

(c) $f(x) = \frac{1}{2} + \sum_{n=1}^{\infty} \frac{2}{n\pi} \sin\frac{n\pi}{2} \sin nx$

(d) $f(x) = \sum_{n=1}^{\infty} \frac{2}{n\pi} \sin\frac{n\pi}{2} \sin nx$

1.4. Consider the following two statements:

I. The maximum number of linearly independent column vectors of a matrix A is called the rank of A.

II. If A is an n x n square matrix, it will be nonsingular if rank A = n. With reference to the above statements, which of the following applies?

(a) Both the statements are false. (b) Both the statements are true.

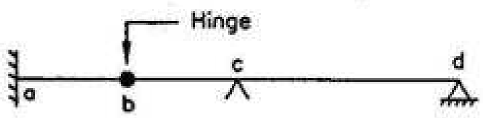
(c) I is true but II is false. (d) I is false but II is true.

1.5. The dimensions for the flexural rigidity of a beam element in mass (M), length (L) and time (T) is given by

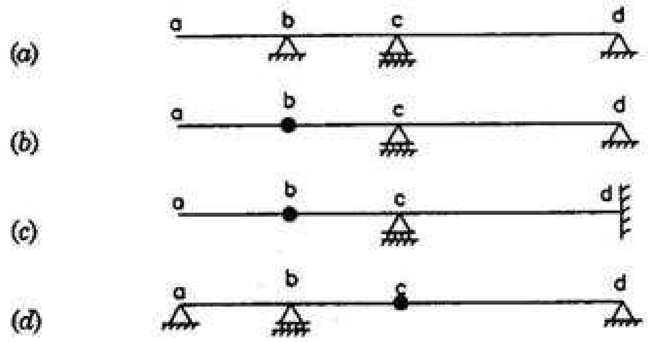
- MT -2 (b) ML 3T -2

(c) ML -lT -2 (d) ML -l T 2

1.6. A two span beam with an internal hinge is shown below.



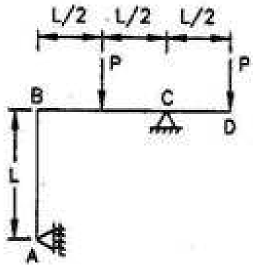
The conjugate beam corresponding to this beam is



1.7. Pick the incorrect statement from the following four statements:

- On the plane which carries maximum normal stress, the shear stress is zero.
- Principal planes are mutually orthogonal.
- On the plane which carries maximum shear stress, the normal stress is zero.
- The principal stress axes and principal strain axes coincide for an isotropic material.

1.8. A frame ABCD is supported by a roller at A and is on a hinge at C as shown below:



The reaction at the roller end A is given by

(a) P (b) 2 P

(c) P/2 (d) Zero.

1.9. The following two statements are made with reference to a simply supported under-reinforced RCC beam:

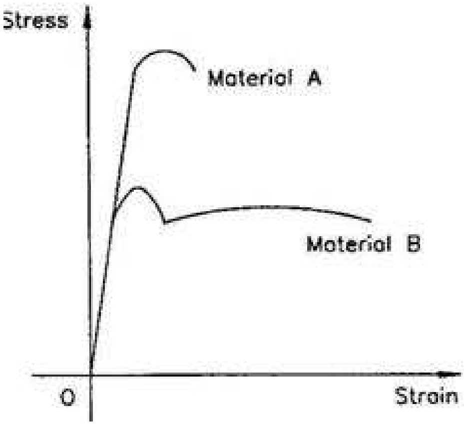
I. Failure takes place by crushing of concrete before the steel has yielded.

II. The neutral axis moves up as the load is increased.

With reference to the above statements, which of the following applies?

- Both the statements are false.
- I is true but II is false.
- Both the statements are true.
- I is false but II is true.

1.10. The stress-strain diagram for two materials A and B is shown below:



The following statements are made based on this diagram:

(I) Material A is more brittle than material B.

(II) The ultimate strength of material B is more than that of A.

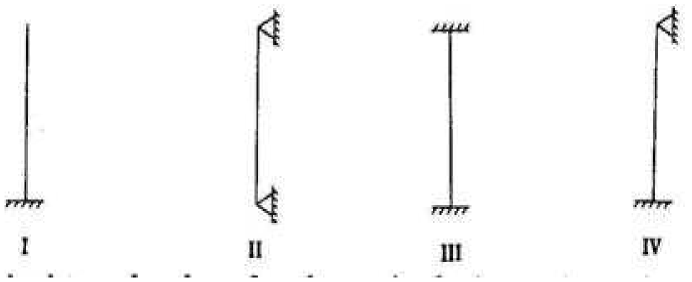
With reference to the above statements, which of the following applies?

- Both the statements are false. (b) Both the statements are true.

(c) I is true but II is false. (d) I is false but II is true.

1.11. Four column of the same material and having identical geometric properties

are supported in different ways as shown below:



It is required to order these four beams in the increasing order of their respective first buckling loads. The correct order is given by

(a) I, II, III, IV (b) III, IV, I, II

(c) II, I, IV, III (d) I, II, IV, III

1.12. A soil sample has a void ratio of 0.5 and its porosity will be close to

- 50%
- 66%
- 100%
- 33%

1.13. A borrow pit soil has a dry density of 17 kN/m 3. How many cubic meters of this soil will be required to construct an embankment of 100 m 3 volume with a dry density of 16 kN/m 3.

(a) 94 m 3 (b) 106 m 3

(c) 100 m 3 (d) 90 m 3

1.14. The group efficiency of a pile group

(a) will be always less than 100%.

(b) will be always greater than 100%

(c) may be less than 100% or more than 100%.

(d) will be more than 100% for pile groups in cohesion less soils and less than 100% for those in cohesive soils.

1.15. The two criteria for the determination of allowable bearing capacity of a foundation are

(a) tensile failure and compression failure.

(b) tensile failure and settlement.

(c) bond failure and shear failure.

(d) shear failure and settlement.

1.16. If duty (D) is 1428 hectares/cumec and base period (B) is 120 days for an irrigated

crop, then delta (D) in meters is given by

(a) 102.8 (b) 0.73

(c) 1.38 (d) 0.01

1.17. The relation that must hold for the flow to be irrotational is

(a) $\frac{\partial u}{\partial y} - \frac{\partial v}{\partial x} = 0$ (b) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$

(c) $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} = 0$ (d) $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$

1.18. Cavitation is caused by

(a) high velocity (b) low pressure

(c) high pressure (d) high temperature

1.19. If the pump head is 15m, discharge is 0.464 m 3/s and the motor speed is 1440 rpm at rated condition, the specific-speed of the pump is about

(a) 4 (b) 26

(c) 38 (d) 1440

1.20. The BOD removal efficiency, in percentage, during primary treatment, under normal conditions is about

(a) 65% (b) 85%

(c) 30% (d) Zero

1.21. Critical factors for the activated sludge treatment process are

(a) maximum hourly flow rate.

(b) maximum and minimum flow rate.

(c) maximum hourly flow rate and maximum daily organic load.

(d) minimum hourly flow rate and minimum daily organic load.

1.22. Use of coagulants such as alum

(a) results in reduction of pH of the treated water.

(b) results in increase of pH of the treated water.

(c) results in no change in pH of the treated water.

(d) may cause an increase or decrease of pH of the treated water.

1.23. The disinfection efficiency of chlorine in water treatment

(a) is not dependent on pH value.

(b) is increase by increased pH value.

(c) remains constant at all pH values.

(d) is reduced by increased pH value.

1.24. The standard plate size in a plate bearing test for finding modulus of subgrade reaction (k) value is

- 100 cm diameter
- 50 cm diameter
- 75 cm diameter
- 25 cm diameter

1.25. Width of carriageway for a single lane is recommended to be

(a) 7.5 m (b) 7.0 m

(c) 3.75 m (d) 5.5 m

1.26. Stopping sight distance is the minimum distance available on a highway which is the

(a) distance of sufficient length to stop the vehicle without collision.

(b) distance visible to a driver during night driving.

(c) height of the object above the road surface.

(d) distance equal to the height of the driver's eye above the road surface.

1.27. Bituminous materials are commonly use in highway construction because of their good

(a) tensile and compression properties.

(b) binding and water proofing properties.

(c) shear strength and tensile properties.

(d) bond and tensile properties.

2. This question consists of24 (Twenty Four) multiple-choice type sub-questions, each carrying TWO marks. The answers to the multiple choice questions MUST be written only in the boxes corresponding to the question numbers writing A, B, C or D in the answer book. (24 x 2 = 48)

2.1. If f(x, y, z) = (x 2 +y 2 +z 2) -1/2

$\frac{\partial^2 f}{\partial x^2}+\frac{\partial^2 f}{\partial y^2}+\frac{\partial^2 f}{\partial z^2}$ is equal to

- Zero
- 1
- 2
- \- 3 (x 2 + y 2 + z 2) -5/2

2.2. The Taylor expansion of sin x about x = p /6 is given by

(a) $\frac{1}{2}+\frac{\sqrt{3}}{2}\left(x-\frac{\pi}{6}\right)-\frac{1}{4}\left(x-\frac{\pi}{6}\right)^2-\frac{\sqrt{3}}{12}\left(x-\frac{\pi}{6}\right)^3+\ldots$

(b) $x-\frac{x^3}{3!}+\frac{x^5}{5!}-\frac{x^7}{7!}+\ldots$

(c) $\left(x-\frac{\pi}{6}\right)-\frac{\left(x-\frac{\pi}{6}\right)^3}{3!}+\frac{\left(x-\frac{\pi}{6}\right)^5}{5!}-\frac{\left(x-\frac{\pi}{6}\right)^3}{7!}+\ldots$

(d) $\frac{1}{2}$

2.3. Let F(s) =£ [f(t)] denote the Laplace transform of the function f(t). Which of the following statements is correct?

(a) £ $\left[\frac{df}{dt}\right]=\frac{1}{s}F(s);$ £ $\int_0^t f(\tau)d\tau = sF(s)-f(0);$

(b) £ $\left[\frac{df}{dt}\right]=sF(s)-F(0);$ £ $\left[\int_0^t f(\tau)d\tau\right]=\frac{dF}{ds}$

(c) £ $\left[\frac{df}{dt}\right]=sF(s)-F(0);$ £ $\left[\int_0^t f(\tau)d\tau\right]=F(s-a)$

(d) £ $\left[\frac{df}{dt}\right]=sF(s)-F(0);$ £ $\left[\int_0^t f(\tau)d\tau\right]=\frac{1}{s}F(s)$

2.4. The limit of the function f(x) = [1- a 4 / x 4] as x ® ¥ is given by

- 1
- exp[- a 4]
- ¥
- Zero

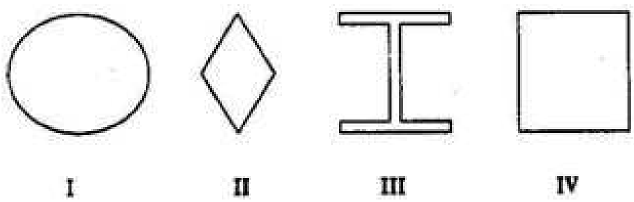
2.5. The maxima and minima of the function $f(x) = 2x^3 - 15x^2 + 36x + 10$ occur, respectively, at

(a) X = 3 and X = 2 (b) X = 1 and X = 3

(c) X = 2 and X = 3 (d) X = 3 and X = 4

2.6. The four cross sections shown below are required to be ordered in the increasing

order of their respective shape factors.

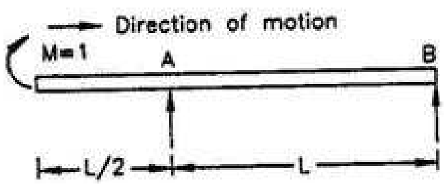


Which of the following order is correct?

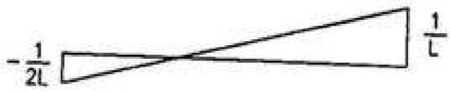
(a) III, I, IV, II (b) I, II, III, IV

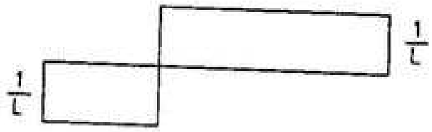
(c) III, IV, I II (d) III, IV, II, I

2.7. A simply supported beam with an- overhang is traversed by a unit concentrated moment from the left t>a. the right as shown below:



The influence line for reaction at B is given by

(a) 

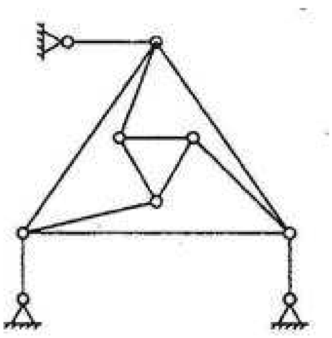
(b) 

(c) 

(d) zero everywhere

2.8. The following two statements are made with reference to the planar truss shown

below:



I. The truss is statically determinate

II. The truss is kinematically determinate

With reference to the above statements, which of the following applies?

(a) Both statements are true. (b) Both statements are false.

(c) II is true but I false. (d) I is true but II is false.

2.9. A cantilever beam of length L and a cross section with shape factor f supports a concentrated load P as shown below:

The length L p of the plastic zone, when the maximum bending moment, equals the plastic moment M p, given by

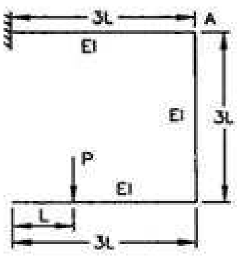
(a) $\frac{Lp}{L} = \frac{1}{f}$

(b) $\frac{Lp}{L} = L(1-f)$

(c) $\frac{Lp}{L} = 1 - \frac{1}{\sqrt{f}}$

(d) $\frac{Lp}{L} = 1 - \frac{1}{f}$

2.10. For the structure shown below, the vertical deflection at point A is given by



(a) $\frac{PL^3}{81EI}$

(b) $\frac{2PL^3}{81EI}$

(c)Zero

(d) $\frac{PL^3}{72EI}$

2.11. The ultimate bearing capacity of a soil is 300 kN/m 2. The depth of foundation is 1m and unit weight of soil is 20 kN/m 3. Choosing a factor of safety of 2.5, the net safe bearing capacity is

(a) 100 kN/m 2 (c) 80 kN/m 2

(b) 112 kN/m 2 (d) 100.5 kN/m 2

2.12. A deep cut of 1m has to be made in a clay with unit weight 16 kN/m 3 and a cohesion of 25 kN/m 2. What will be the factor of safety if one has to have a slope angle of 30°? Stability number is given to be 0.178 (from Taylor's chart) for a depth factor of 3.

(a) 0.80 (c) 1.25

(b) 1.1 (d) 1.0

2.13. In a drained triaxial compression test, a saturated specimen of a cohesion less sand fails under a deviatoric stress of 3 kgf/cm 2 when the cell pressure is 1 kgf/cm 2. The effective angle of shearing resistance of sand is about

(a) 37° (b) 45°

(c) 53° (d) 20°

2.14. Two footings, one circular and the other square, are founded on the surface of a purely cohesion less soil. The diameter of the circular footing is same as that of the side of the square footing. The ratio of their ultimate bearing capacities is

(a) 3/4 (b) 4/3

(c) 1.0 (d) 1.3

2.15. To have zero active pressure intensity at the tip of a wall in cohesive soil, one

should apply a uniform surcharge intensity of

(a) 2 c tan a (b) 2 c cot a

(c) - 2 c tan a (d) - 2 c tan a

2.16. Water flows at a depth of 0.1m with a velocity of 6 m/s in a rectangular channel. The alternate depth is

- 0.30 m
- 0.40 m
- 0.86 m
- 0.81 m

2.17. In an area of 200 hectare, water table drops by 4 m. If the porosity is 0.35 and the

specific retention is 0.15, change in volume of storage in the aquifer is.

(a) 160 m 3 (b) 1.6 x 106 m

(c) 8 x 106 m 3 (d) 1.6 x 103 m 3

2.18. A tube well having a capacity of 4 m 3/hour operates for 20 hours each day during the irrigation season. How much area can be commanded if the irrigation interval

is 20 days and depth of irrigation is 7 cm ?

(a) 1.71×10^4 m^2 (b) 1.14×10^4 m^2

(c) 22.9×10^4 m^2 (d) 2.29×10^4 m^2

2.19. The parameters in Horton's infiltration equation [$f(t) = f_c + (f_o - f_c) e^{-kt}$] are given as, f_o = 7.62 cm/hour, f_c = 1.34 cm/hour and k = 4.182/hour. For assumed continuous ponding the cumulative infiltration at the end of 2 hours is

(a) 2.68 cm (b) 1.50 cm

(c) 1.34 cm (d) 4.18 cm

2.20. Water flows at a rate of 10 m^3/s in a rectangular channel 3 m wide. The critical depth of flow is

- 1.13 m
- 2m
- 1.45 m
- 1.04 m

2.21. A circular sewer 2m diameter has to carry a discharge of 2 m^3/s when flowing nearly full. What is the minimum required slope to initiate the flow? Assume Manning's n = 0.015.

(a) 0.00023 (b) 0.000036

(c) 0.000091 (d) 0.000014

2.22. The following characteristics pertain to the sand filters used in water industry.

- Filtration rate is 1 to 4 $m^3/(m^2\ day)$.
- Typical duration of operation in one run is 24 to 72 hours.

- Operating cost is low.

Which of the above characteristics pertain to slow sand filters?

(a) I, II and III (b) I and II

(c) II and III (d) I and III

2.23. The ruling minimum radius of horizontal curve of a national highway in plain terrain for a ruling design speed of 100 km/hour with $e = 0.07$ and $f = 0.15$ is close to

(a) 250 m (b) 360 m

(c) 36 m (d) 300 m

2.24. Design rate of super elevation for horizontal highway curve of radius 450 m for a mixed traffic condition, having a speed of 125 km/hour is

(a) 1.0 (b) 0.05

(c) 0.07 (d) 0.1.54