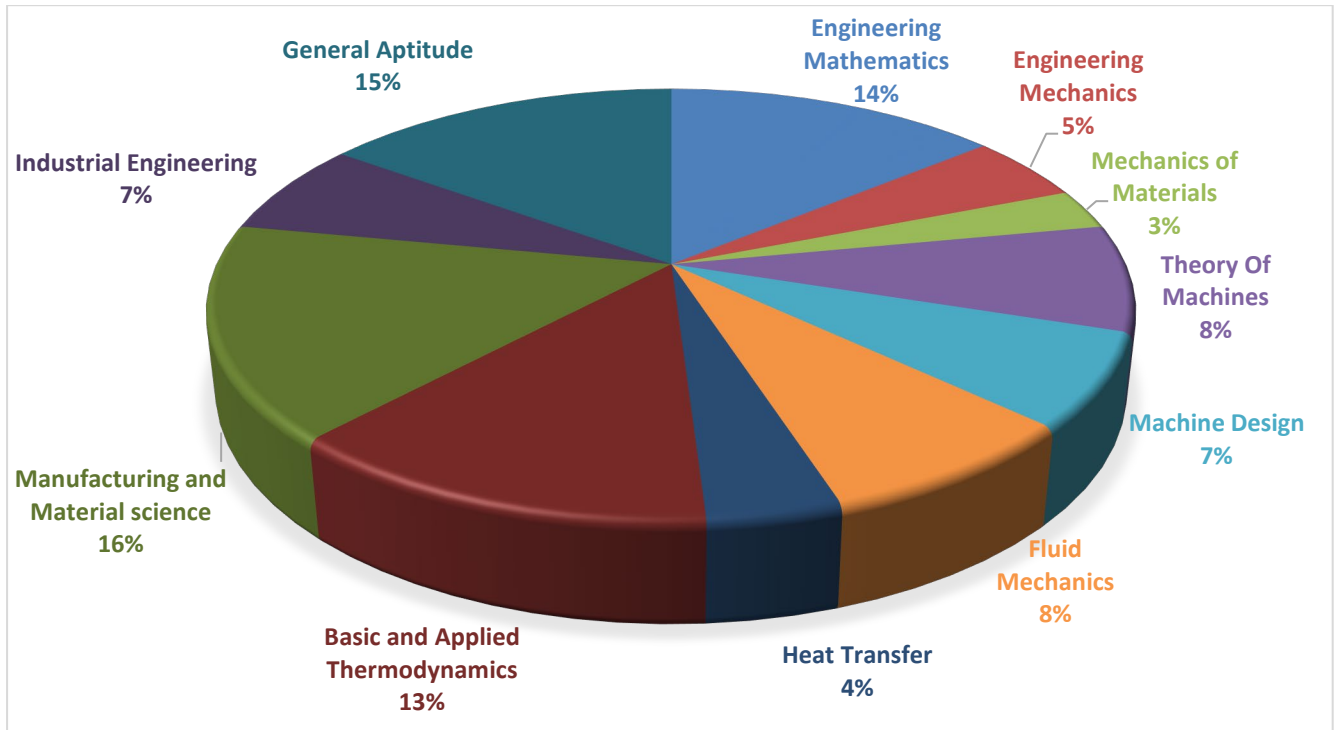




ANALYSIS OF GATE 2020
Memory Based

Mechanical Engineering



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ME ANALYSIS-2020_Feb-1_Morning

SUBJECT	No. of Ques.	Topics Asked in Paper(Memory Based)	Level of Ques.	Total Marks
Engineering Mathematics	1 Marks:6 2 Marks:4	Laplace transform, Vector calculus, Numerical methods, Probability, Correlation and Regression , Complex variables	Average	14
Engineering Mechanics	1 Marks:1 2 Marks:2	Truss	Difficult	5
Mechanics of Materials	1 Marks:1 2 Marks:1	SFD and BMD	Difficult	3
Theory Of Machines	1 Marks:4 2 Marks:2	Vibrations, Four bar, Flywheel	Difficult	8
Machine Design	1 Marks:1 2 Marks:3	Clutch, Theory of failure	Average	7
Fluid Mechanics	1 Marks:2 2 Marks:3	Turbo machinery, Kaplan turbine	Average	8
Heat Transfer	1 Marks:2 2 Marks:1	Convection	Easy	4
Basic and Applied Thermodynamics	1 Marks:3 2 Marks:5	Joule Thomson co-efficient, IC engine, Rankine cycle	Easy	13
Manufacturing and Material science	1 Marks:4 2 Marks:6	Rolling, Metal cutting, Material science	Average	16
Industrial Engineering	1 Marks:1 2 Marks:3	CPM	Difficult	7
General Aptitude	1 Marks:5 2 Marks:5	Series, Function, Data Interpretation, English	Average	15
Total	65			100
Faculty Feedback	Average paper with few difficult subjects.			



GATE 2020 Examination* (Memory Based)

Mechanical Engineering

Test Date: 1st Feb-2020

Test Time: 9.30 am to 12.30 pm

Stream Name: Mechanical Engineering

General Aptitude

Q.1 - Q.5 Carry One Mark each.

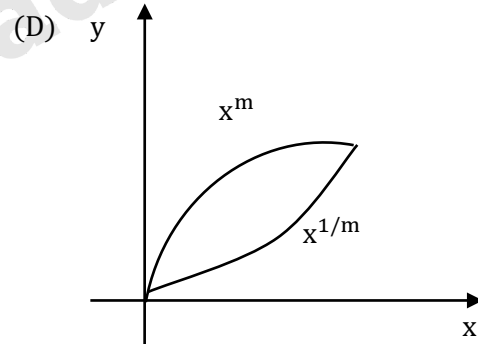
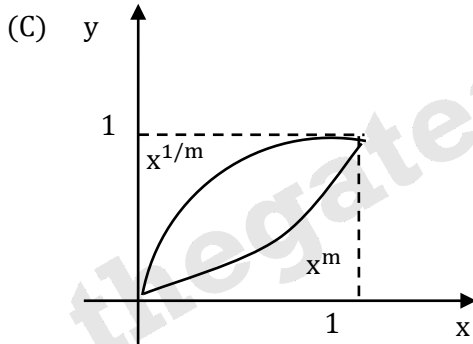
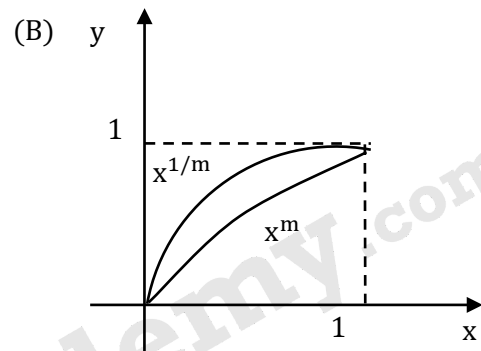
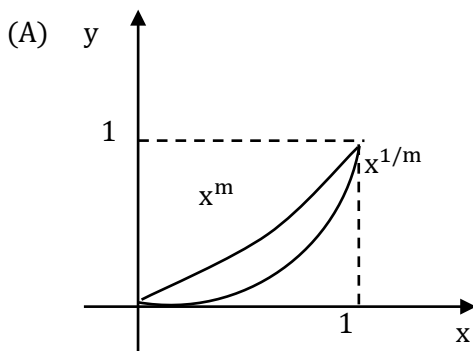
- I do not think you know the case well enough to have opinions. Having said that, I agree with your point.
What does the phrase "having said that" mean?
(A) in addition to what I have said
(B) in opposed to what I have said
(C) contrary to what I have said
(D) despite what i have said
[Ans. D]
- He is known for his unscrupulous ways. He always sheds _____ tears to deceive people.
(A) crocodile
(B) fox
(C) crocodile's
(D) fox's
[Ans. A]
- P, Q, R & S are uniquely coded using α & β . If P is coded as $\alpha\alpha$ and Q is coded as $\alpha\beta$ then R & S respectively. It can be coded as
(A) $\beta\alpha$ & $\beta\beta$
(B) $\alpha\beta$ & $\beta\beta$
(C) $\beta\beta$ & $\alpha\alpha$
(D) $\alpha\alpha$ & $\beta\beta$
[Ans. *]
- Build: Building, Grow: _____
(A) Grew
(B) Grown
(C) Growth
(D) Grow
[Ans. C]



5. Jofra archer, the England fast bowler is _____ than accurate.
 (A) More fast
 (B) More faster
 (C) Faster
 (D) Less faster
[Ans. *]

Q.6 - Q.10 Carry Two Mark each.

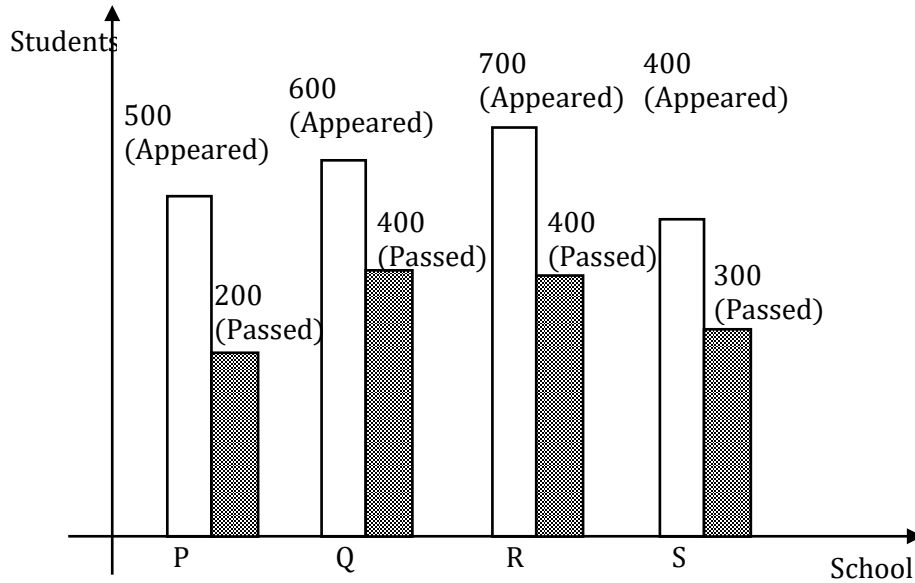
6. Select the graph that schematically represents both $y = x^m$ and $y = x^{1/m}$ properly in the interval $0 \leq x \leq 1$ for integer value of m , where $m > 1$



[Ans. C]

7. The sum of the first n terms in the sequence 8, 88, 888, 8888, ... is _____
 (A) $\frac{80}{81}(10^n - 1) + \frac{8}{9}n$
 (B) $\frac{80}{81}(10^n - 1) - \frac{8}{9}n$
 (C) $\frac{81}{80}(10^n - 1) + \frac{8}{9}n$
 (D) $\frac{81}{80}(10^n - 1) - \frac{8}{9}n$
[Ans. B]

8. What is the success of student of school P, Q, R, S in the given bar graph?



- (A) 59.3%
 (B) 52%
 (C) 53%
 (D) 50%

[Ans. A]

9. If x indicates greatest integer function such that $[x]$: greatest integer less than equal to x .
 If $y = [x]$, then area under y for is $x \in [1, 4]$ is

- (A) 4
 (B) 1
 (C) 3
 (D) 6

[Ans. *]

10. A



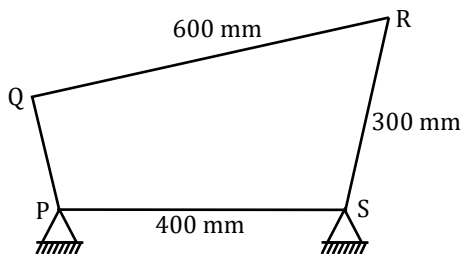
Technical

Q.1 - Q.25 Carry One Mark each.

1. A helical gear with 20° pressure angle and 30° helix angle mounted at the midspan of the shaft that is supported between two bearings at the ends. The nature of the stress-induced in the shaft is
- (A) Normal stress due to bending only
 (B) Normal stress due to bending in one plane and axial loading
 (C) Normal stress due to bending in two plane, shear stress due to torsion
 (D) Normal stress due to bending in two planes and axial loading, shear stress due to torsion.

[Ans. *]

2. A four bar mechanism is shown below



For the mechanism to be a crank-rocker mechanism, the length of the link PQ can be

- (A) 200 mm
 (B) 80 mm
 (C) 350 mm
 (D) 300 mm

[Ans. *]

3. The velocity field of an incompressible flow is

$$\vec{V} = 2(x^2 - y^2)\hat{i} + v\hat{j} + 3\hat{k}$$

Which of the following expression for v is valid?

- (A) $-4xz - 4xz$
 (B) $-4xz + 6xy$
 (C) $4xz - 6xy$
 (D) $4xy + 4xz$

[Ans. A]



4. Froude number is the ratio of
 (A) Buoyancy force to inertia force
 (B) Inertia force to gravity force
 (C) Inertia force to viscous force
 (D) Buoyancy force to viscous force

[Ans. A]

5. Match List-I (Dimensionless Number) with List-II (Definition)

List-I	List-II
P. Reynolds Number	1. $\frac{\text{Buoyant force}}{\text{Viscous force}}$
Q. Grashof Number	2. $\frac{\text{Momentum diffusivity}}{\text{Thermal diffusivity}}$
R. Nusselt Number	3. $\frac{\text{Inertia Force}}{\text{Viscous Force}}$
S. Prandtl Number	4. $\frac{\text{Convection Heat Transfer}}{\text{Conductive Heat Transfer}}$

- (A) P-1, Q-3, R-3, S-4
 (B) P-3, Q-1, R-4, S-2
 (C) P-3, Q-1, R-2, S-4
 (D) P-4, Q-3, R-1, S-2

[Ans. B]

6. For an Ideal gas, a constant pressure and a constant volume line intersect at a point, in the temperature (T) versus specific entropy (s) diagram. The ratio of the slopes of the constant pressure and constant volume lines at the point of intersection is

- (A) $\frac{C_p}{C_v}$
 (B) $\frac{C_v}{C_p}$
 (C) $\frac{C_p - C_v}{C_p}$
 (D) $\frac{C_p - C_v}{C_v}$

[Ans. B]

7. For an Ideal gas, the volume of Joule Thompson coefficient is

- (A) Indeterminate
 (B) Negative
 (C) Zero
 (D) Positive

[Ans. C]



8. The compression of gas turbine plant operating on an ideal intercooled Brayton cycle, accomplishes an overall compression ratio of 6 in a two stage compression process. Air enters the compressor at 300 K and 100 kPa. If the properties of gas are constant, the intercooling pressure for minimum compressor work is _____ kPa.

[Ans. *]Range: 244 to 246

9. The stress state at a point in a material under plane stress condition is equi-biaxial tension with a magnitude of 10 MPa. If one unit of $\sigma - \tau$ plane is 1 MPa. The Mohr's circle representation of the state-of-stress is given by

- (A) A circle with a radius of 10 units on the $\sigma - \tau$ p lane.
 (B) A point on the σ axis at a distance of 10 units from the origin.
 (C) A circle with radius equal to principal stress and its centre at the origin of $\sigma - \tau$ plane.
 (D) A point on the τ axis at a distance of 10 units from the origin

[Ans. *]

10. To a system having transfer function $\frac{1}{s+1}$; $\sin t$ is applied as input. The input will be

- (A) $\frac{1}{2} \sin t$
 (B) $\frac{1}{\sqrt{2}} \sin \left(t - \frac{\pi}{4} \right)$
 (C) $\frac{1}{\sqrt{2}} \cos t$
 (D) $\frac{1}{2} \cos \left(t - \frac{\pi}{4} \right)$

[Ans. *]

11. Which of the following complex function $f(z)$, of the complex variable z , is not analytic at all points of the complex plane?

- (A) e^z
 (B) $\log z$
 (C) $\sin z$
 (D) z^2

[Ans. B]

12. Multiplication of real valued square matrices of same dimension is

- (A) Commutative
 (B) Associative
 (C) Always positive definite
 (D) Not always possible to compute

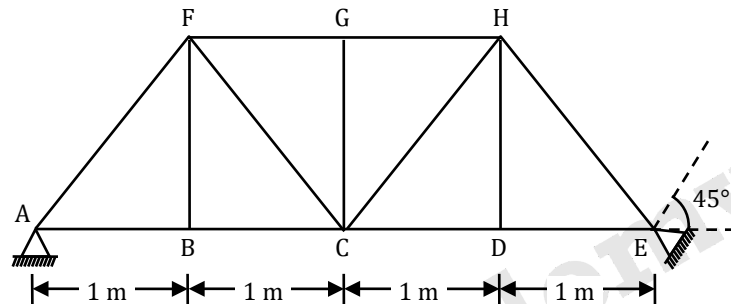
[Ans. B]

13. $\lim_{x \rightarrow 1} \left[\frac{1 - e^{-C(1-x)}}{1 - x e^{-C(1-x)}} \right]$

- (A) C
 (B) $\frac{C}{C+1}$
 (C) $\frac{C+1}{C}$
 (D) C + 1

[Ans. B]

14. The member carrying zero force (i.e., zero force members) in the truss shown in the figure, for any load $P > 0$ with no appreciable determination of the truss (i.e., with no appreciable change in angles between the members) are



- (A) BF, DH and GC only
 (B) BF, DH, GC, CD and DE only
 (C) BF, DH, GC, FG and GH only
 (D) BF and DH only

[Ans. *]

15. The base of brass bracket needs rough grinding, for this purpose, the most suitable grinding wheel specification is

- (A) C 30 Q 12 V
 (B) A 30 D 12 V
 (C) C 90 J 4 B
 (D) A 50 G 8 V

[Ans. *]

16. A sheet metal with a stock hardness of 250 HRC has to be sheared using a punch and a die having a clearance of 1 mm between them. If the hardness of the sheet metal increases to 400 HRC the clearance between the punch and the die should be _____ mm.

[Ans. *]

17. Match the following.

List-I

- P. Tempering
 Q. Quenching
 R. Annealing
 S. Normalizing

List-II

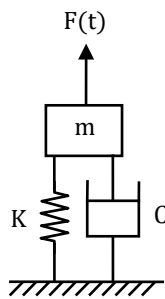
1. Strengthening
 2. Toughening
 3. Hardening
 4. Softening

Codes:

	P	Q	R	S
(A)	2	3	4	1
(B)	1	1	3	2
(C)	4	3	2	1
(D)	3	3	1	2

[Ans. *]

18. A single degree of freedom is subjected to harmonic excitation $F(t) = F_0 \cos(\omega t)$ as shown in the figure

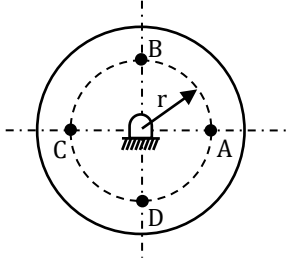


The non-zero value of ω , for which the amplitude of the force transmitted to the ground will be F_0 , is

- (A) $\sqrt{\frac{K}{m}}$
 (B) $2\sqrt{\frac{K}{m}}$
 (C) $\sqrt{\frac{2K}{m}}$
 (D) $\sqrt{\frac{K}{2m}}$

[Ans. *]

19. A balanced rigid disc mounted on a rigid rotor has four identical point masses, each of 10 grams, attached to four points on the 100 mm radius circle shown in the figure.



The rotor is driven by a motor at uniform angular speed of 10 rad/s. If one of the masses get detached then the magnitude of the resultant unbalanced force on the rotor is _____ N

[Ans. *]

20. A
21. A
22. A
23. A
24. A
25. A

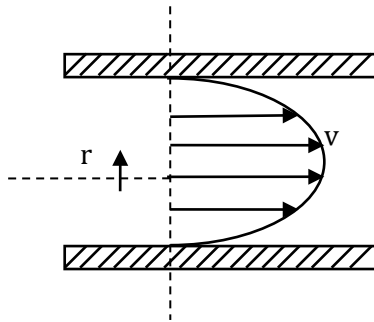
Q.26 - Q.55 Carry Two Mark each.

26. Consider steady, viscous fully developed flow of a fluid through a circular pipe of internal diameter D , the velocity is given by

$$V = -c \left(r^2 - \frac{D^2}{4} \right) \text{ m/sec}$$

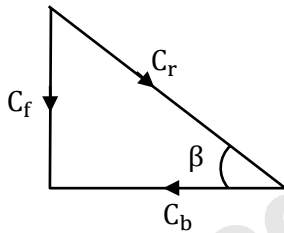
The rate of kinetic energy in (J/sec) at the control surface AB as shown in the figure is proportional to D^n

The value of D^n is _____



[Ans. *]

27. For Kaplan (axial flow) turbine, the outlet blade velocity diagram at a section is shown



C_f = Flow velocity

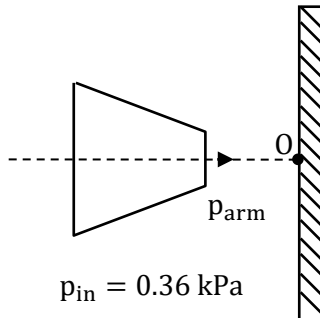
C_b = Blade velocity

C_r = Relative velocity

The diameter at this section is 3 m. The hub and tip diameter of the blade are 2 m and 4 m respectively. The water volume flow rate is $1000 \text{ m}^3/\text{sec}$. The rotational speed of the turbine is 300 rpm. The blade output angle β is _____ degrees.

[Ans. *]

28. Air discharges steadily through a nozzle and impinges upon a stationary vertical plate as shown in figure



The in and out area of nozzle are 0.1 m^2 and 0.02 m^2 respectively (air density is 1.2 kg/m^3). If the inlet gauge pressure of air is 0.036 kPa . The gauge pressure at point O on the plate is _____ kPa.

[Ans. *]

29. The indicated power developed by an engine with compression ratio 8, is calculated using an air standard ratio Otto cycle. The rate of heat addition is 10 kW . The ratio of specific heats at constant pressure and constant volume is 1.4. The mechanical efficiency of the engine is 80%. The brake power output of the engine is _____ kW

[Ans. *] Range: 4.5 to 4.55

30. One kg of air, initially at a temperature of 127°C , expands reversibly at a constant pressure until the volume is doubles. If gas constant of air is 2.87 J/kg.K . The magnitude of work transfer is _____ kJ

[Ans. *] Range: 1.1 to 1.2

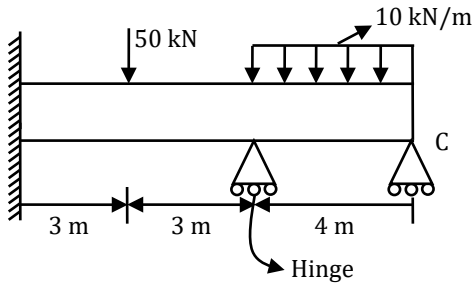
31. For an ideal Rankine cycle operating between Pressure of 30 bar and 0.04 bar, the work output from the turbine is 903 kJ/kg and the work input to the feed pump is 3 kJ/kg . The specific steam consumption is _____ kg/kWh

[Ans. *] Range: 3.9 to 4.1

32. Air (ideal gas) enters perfectly insulated compression at a temperature of 310 K . The pressure ratio of the compression is 6. Specific heat at constant pressure for air is 1005 J/kgK and ratio of specific heats at constant pressure and constant volume is 1.4. If the isentropic efficiency of the compressor is 85%. The difference in enthalpies of air between the exit and inlet of the compressor is _____ kJ/kg

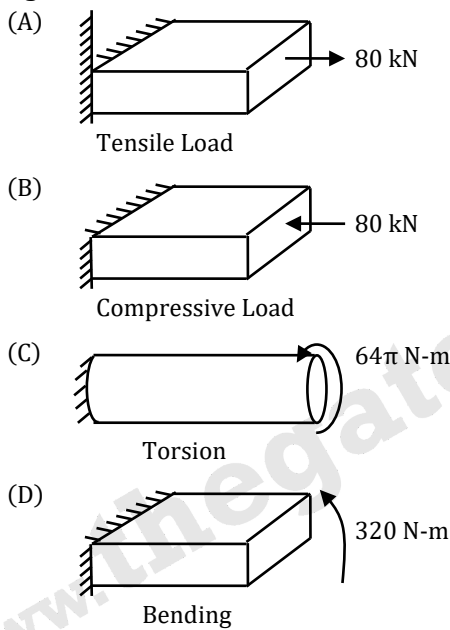
[Ans. *] Range: 244 to 246

33. The magnitude of reaction force at joint 'C' of the hinge-beam in the figure is _____ kN.



[Ans. *]

34. Bars of square and circular cross-section with 0.5 m length are made of a material with shear strength of 20 MPa. The square bar cross-section dimension is 4 cm × 4 cm and cylindrical bar cross-section diameter is 4 cm. The specimens are loaded as shown in the figure.

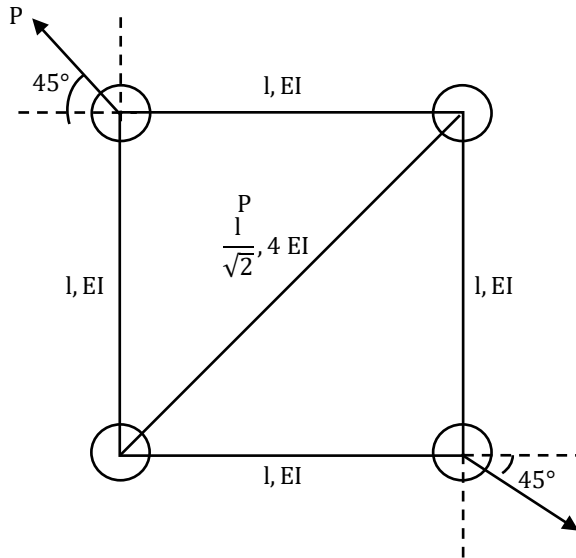


Which specimen will fail due to the applied load as per maximum shear stress theory?

- (A) None of the specimen
- (B) Torsional load specimen
- (C) Tensile and compressive load specimen
- (D) Bending load specimen

[Ans. *]

35. The truss shown in the figure has focal members of length l and flexural rigidity EI , and one member of length $l/\sqrt{2}$ and flexural rigidity $4EI$. The truss is loaded by a pair of forces of magnitude P , as shown in the figure.



The smallest value of P , at which any of the truss members will buckle is

- (A) $\frac{2\pi^2 EI}{l^2}$
 (B) $\frac{\pi^2 EI}{l^2}$
 (C) $\frac{\pi^2 EI}{2l^2}$
 (D) $\frac{\sqrt{2}\pi^2 EI}{l^2}$

[Ans. *]

36. $f(z) = x^2 - x^2 + i\psi(x, y)$ is analytic function. The value of imaginary part of $f(z)$ of $z = 1 + i$ is _____.

[Ans. *] Range: 2 to 2

37. Consider two exponentially distributed random variables X & Y , both having a mean of 0.5. Let $Z = X + Y$ and r be the correlation coefficient between X & Y . If variance of z is 0, the value of r is _____.

[Ans. *] Range: -1 to -1



38. The value of the integral $\int_{-1}^{1.4} x|x|dx$ using Simpson's 1/3 rd rule with step size as 0.6 is _____.

- (A) 0.581
- (B) 0.914
- (C) 0.592
- (D) 1.248

[Ans. C]

39. A vector field is defined as

$$\vec{F}(x, y, z) = \frac{x}{(x^2+y^2+z^2)^{3/2}} \mathbf{i} + \frac{y}{(x^2+y^2+z^2)^{3/2}} \mathbf{j} + \frac{z}{(x^2+y^2+z^2)^{3/2}} \mathbf{k}$$

the double integral $\iint \vec{F} \cdot \vec{ds}$ is evaluated over the inner & outer surfaces of a spherical shell formed by 2 concentric spheres with origin as the centre & internal and external radii of 1 & 2 units respectively, is _____

- (A) 4π
- (B) 0
- (C) 8π
- (D) 2π

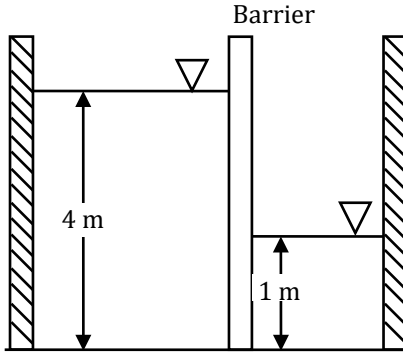
[Ans. B]

40. For the matrix $\begin{bmatrix} 1 & -1 & 0 \\ 1 & -2 & 1 \\ 0 & -1 & 1 \end{bmatrix}$ has eigen vector

- (A) $\begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$
- (B) $\begin{bmatrix} -1 \\ 1 \\ -1 \end{bmatrix}$
- (C) $\begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix}$
- (D) $\begin{bmatrix} 1 \\ 1 \\ -1 \end{bmatrix}$

[Ans. A]

41. The barrier shown between two tanks of unit width (1 m) into the plane of the screen is modeled as cantilever



Taking the density of water as 1000 kg/m^3 , $g = 10 \text{ m/s}^2$ the maximum absolute bending moment developed in the cantilever is _____ kN-m (Round off to nearest integer)

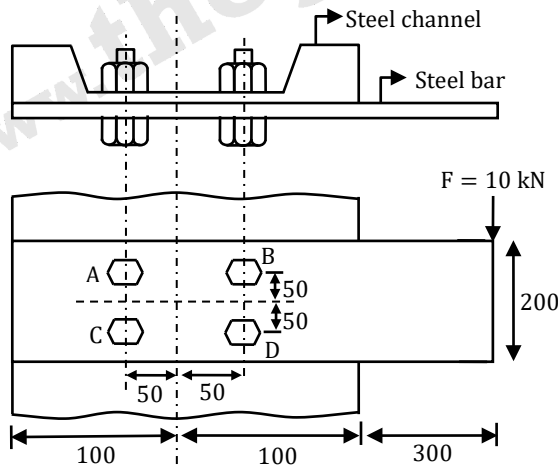
[Ans. *]

42. In a disc type axial clutch, the frictional contact takes place within an annular region with outer and inner diameters 250 mm and 50 mm respectively. An axial force F_1 is needed to transmit a torque by a new clutch. However to transmit the same torque, one needs on axial force F_2 when the clutch wears out. If contact pressure remains uniform during operation of a new clutch while the wear is assumed to be uniform for an old clutch and the coefficient of friction does not change, then the ratio F_1/F_2 is _____

[Ans. *]

43. A rectangular steel bar of length 500 mm, width 100 mm thickness 15 mm is cantilevered to a 200 mm steel channel using 4 bolts, as shown

[All dimensions in mm]



For an external load of 10 kN applied at the tip of the steel bar, the resultant shear load on the bolt at B is _____ kN.

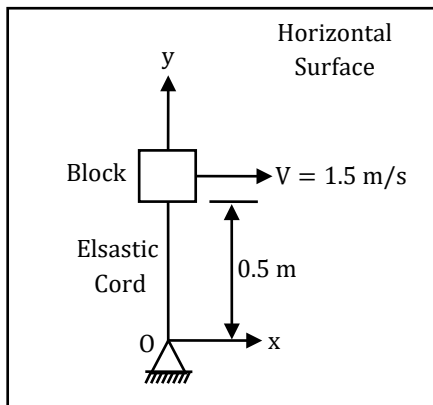
[Ans. *]



44. For a basic shaft system
Tolerance of hole = 0.002 mm
Tolerance of shaft = 0.001 mm
Allowance = 0.003 mm
Basic size = 50 mm
Then maximum hole size is _____ mm.
[Ans. *]
45. A strip of thickness 40 mm is to be rolled to a thickness of 20 mm using a 2 high mill having roll diameter as 200 mm. Coefficient of friction and arc length in mm are
(A) 0.45 and 38.84
(B) 0.45 and 44.72
(C) 0.39 and 38.84
(D) 0.39 and 44.72
[Ans. *]
46. A slot of 25 mm × 25 mm is to be milled in a workpiece of 300 mm length using a side and face milling cutter of diameter 100 mm, width 25 mm and having 20 teeth. For depth of cut 5 mm, feed per tooth 0.1 mm, cutting speed 35 m/min and approach and area travel distance of 5 mm each, the time required for milling the slot is _____ minutes.
[Ans. *]
47. Steel part with surface area 125 cm² is to be chrome coated through an electroplating process using chromium acid sulphate as an electrolyte. An increasing current is applied to the part according to following relation
 $I = 12 + 0.2 t$
Where, I = current (in s), t = time 1 m)
The part is submerged in the plating solution for a duration of 20 minutes for plating purpose. Assuming the cathode deficiency.
[Ans. *]
48. The thickness of steel plate with material strength coefficient 210 MPa, has to be reduced from 20 mm to 15 mm in a single pass in a 2 high rolling mill with a roll radius of 450 mm and rolling velocity of 28 m/min. If the plate has a width of 200 mm and its strain hardening exponent n is 0.25, the rolling force required for the operation is _____ kN.
[Ans. *]

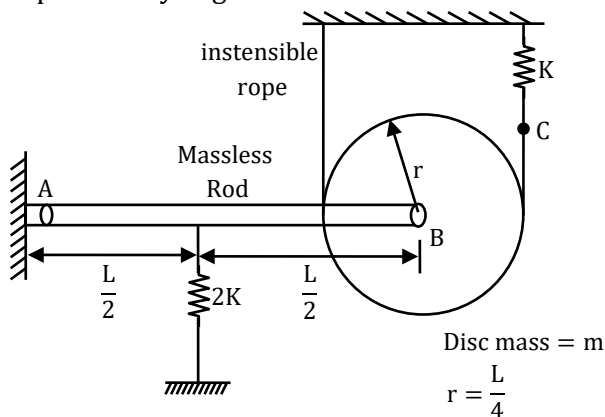
49. A cam with a translating flat-face follower is desired to have following motion
 $y(\theta) = 4[2\pi\theta - \theta^2]$, $0 \leq \theta \leq 2\pi$
 Contact stress considerations dictate that the radius of curvature of the cam profile should not be less than 40 mm anywhere. The minimum permissible base circle radius is _____ mm
[Ans. *]

50. The 2 kg block shown in figure (top view) rests on a smooth horizontal surface and is attached to a massless elastic cord that has a stiffness 5N/m.



- The cord hinged at O is initially unstretched and always remains elastic. The block is given a velocity V of 1.5 m/s perpendicular to the cord. The magnitude of velocity in m/s of the block at the instant the cord is stretched by 0.4 m
[Ans. *]

51. A rigid mass-less rod of length l is connected to a disc (pulley) of mass m and radius $r = \frac{L}{4}$ through a friction-less revolute joint. The outer end of that rod is attached to a wall through a friction-less hinge. A spring of stiffness $2K$ is attached to the rod at its mid-span. An inextensible rope passes over half the disc periphery and is securely tied to a spring of stiffness K at point C as shown in the figure. There is no slip between the rope and the pulley. The system is in static equilibrium in the configuration shown in the figure, and the rope is always tight.





Neglecting the influence of gravity, the natural frequency of the system for small amplitude vibration is

(A) $\frac{3}{\sqrt{2}} \sqrt{\frac{K}{m}}$

(B) $\sqrt{\frac{3}{2}} \sqrt{\frac{K}{m}}$

(C) $\sqrt{3} \sqrt{\frac{K}{m}}$

(D) $\sqrt{\frac{K}{m}}$

[Ans. *]

45. A

46. A

47. A

48. A

49. A

50. A

51. A

52. A

53. A

54. A

55. A

56. A

57. A

58. A



59. A

60. A

61. A

62. A

63. A

64. A

65. A

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