GATE 2020

Graduate Aptitude Test in Engineering 2020

IIT Delhi
Organising Institute

ME1: Mechanical Engineering

GA - General Aptitude

Q1 - Q5 carry one mark each.

Q.No. 1 He is known for his unscrupulous ways. He always sheds_____tears to deceive people.

(A) fox's
(B) crocodile's
(C) crocodile
(D) fox

Q.No. 2 Jofra Archer, the England fast bowler, is_____than accurate.

(A) more fast
(B) faster
(C) less fast
(D) more faster

Q.No. 3 Select the word that fits the analogy:

Build : Building :: Grow : _____

(A) Grown
(B) Grew
(C) Growth
(D) Growed

Q.No. 4 I do not think you know the case well enough to have opinions. Having said that, I agree with your other point.
What does the phrase "having said that" mean in the given text?

(A) as opposed to what I have said
(B) despite what I have said
(C) in addition to what I have said
(D) contrary to what I have said

Q.No. 5 Define $[x]$ as the greatest integer less than or equal to x, for each $x \in (-\infty, \infty)$. If $y = [x]$, then area under y for $x \in [1,4]$ is _____.

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

Q6 - Q10 carry two marks each.

Q.No. 6

Crowd funding deals with mobilisation of funds for a project from a large number of people, who would be willing to invest smaller amounts through web-based platforms in the project.

Based on the above paragraph, which of the following is correct about crowd funding?

(A) Funds raised through unwilling contributions on web-based platforms.

(B) Funds raised through large contributions on web-based platforms.

(C) Funds raised through coerced contributions on web-based platforms.

(D) Funds raised through voluntary contributions on web-based platforms.

Q.No. 7 P, Q, R and S are to be uniquely coded using α and β. If P is coded as αα and Q as αβ, then R and S, respectively, can be coded as _____.

(A) βα and αβ

(B) ββ and αα

(C) αβ and ββ

(D) βα and ββ

Q.No. 8 The sum of the first n terms in the sequence 8, 88, 888, 8888, … is_____.

(A) $\frac{81}{80}(10^n - 1) + \frac{9}{8}n$

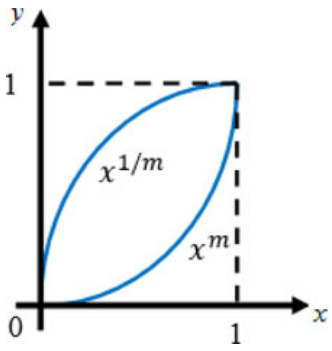
(B) $\frac{81}{80}(10^n - 1) - \frac{9}{8}n$

(C) $\frac{80}{81}(10^n - 1) + \frac{8}{9}n$

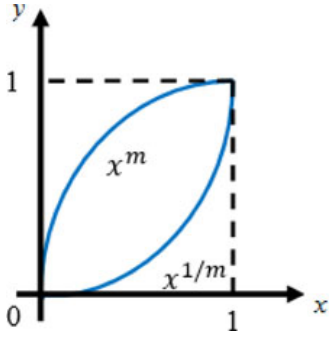
(D) $\frac{80}{81}(10^n - 1) - \frac{8}{9}n$

Q.No. 9 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 values of m, where $m > 1$.

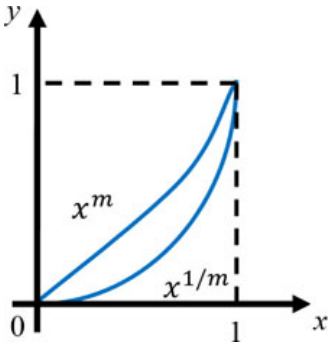
(A)



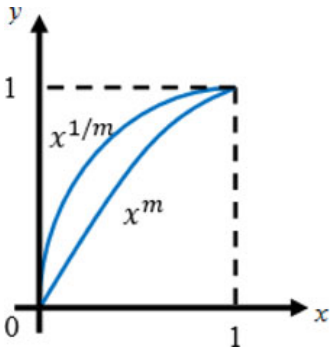
(B)



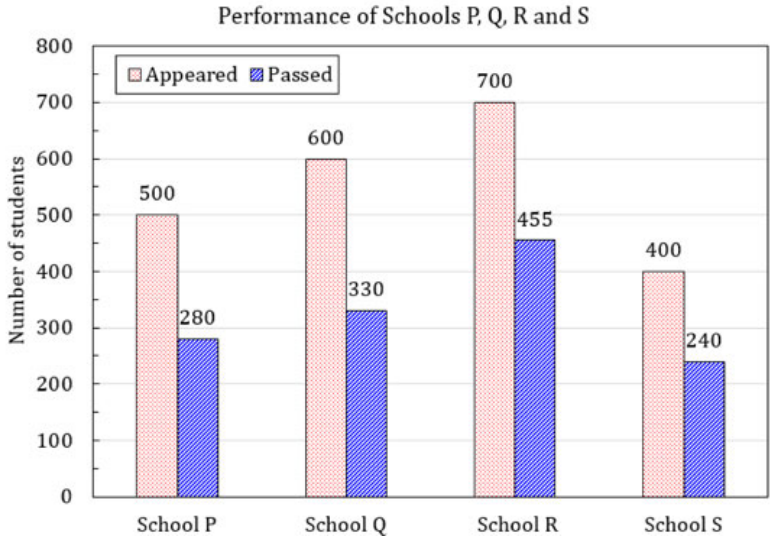
(C)



(D)



Q.No. 10 The bar graph shows the data of the students who appeared and passed in an examination for four schools P, Q, R and S. The average of success rates (in percentage) of these four schools is _____.



(A) 58.5 %

(B) 58.8 %

(C) 59.0 %

(D) 59.3 %

ME1: Mechanical Engineering

Q1 - Q25 carry one mark each.

Q.No. 1 Multiplication of real valued square matrices of same dimension is

(A) associative

(B) commutative

(C) always positive definite

(D) not always possible to compute

Q.No. 2 The value of

$$\lim_{x\to 1}\left(\frac{1-e^{-c(1-x)}}{1-x\,e^{-c(1-x)}}\right) \text{ is}$$

(A) c

(B) $c+1$

(C) $\dfrac{c}{c+1}$

(D) $\dfrac{c+1}{c}$

Q.No. 3 The Laplace transform of a function $f(t)$ is $\mathcal{L}(f)=\frac{1}{(s^2+\omega^2)}$. Then, $f(t)$ is

(A) $f(t)=\dfrac{1}{\omega^2}(1-\cos\omega t)$

(B) $f(t)=\dfrac{1}{\omega}\cos\omega t$

(C) $f(t)=\dfrac{1}{\omega}\sin\omega t$

(D) $f(t)=\dfrac{1}{\omega^2}(1-\sin\omega t)$

Q.No. 4 Which of the following function $f(z)$, of the complex variable z, is **NOT** analytic at all the points of the complex plane?

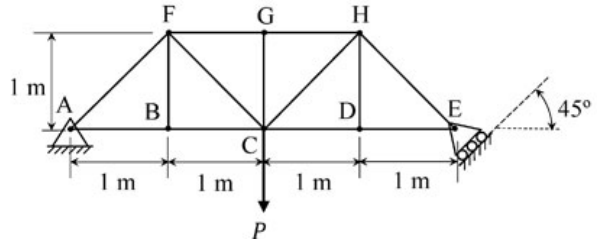
(A) $f(z)=z^2$

(B) $f(z)=e^z$

(C) $f(z)=\sin z$

(D) $f(z)=\log z$

Q.No. 5 The members carrying zero force (i.e. zero-force members) in the truss shown in the figure, for any load $P>0$ with no appreciable deformation of the truss (i.e. with no appreciable change in angles between the members), are



(A) BF and DH only

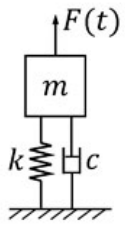
(B) BF, DH and GC only

(C) BF, DH, GC, CD and DE only

(D) BF, DH, GC, FG and GH only

Q.No. 6

A single-degree-of-freedom oscillator 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) $\sqrt{\frac{k}{2m}}$

(B) $\sqrt{\frac{k}{m}}$

(C) $\sqrt{\frac{2k}{m}}$

(D) $2\sqrt{\frac{k}{m}}$

Q.No. 7 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 on the $\sigma - \tau$ plane is 1 MPa, the Mohr's circle representation of the state-of-stress is given by

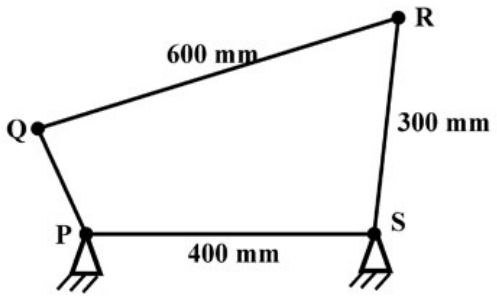
(A) a circle with a radius equal to principal stress and its center at the origin of the $\sigma - \tau$ plane

(B) a point on the σ axis at a distance of 10 units from the origin

(C) a circle with a radius of 10 units on the $\sigma - \tau$ plane

(D) a point on the τ axis at a distance of 10 units from the origin

Q.No. 8 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) 80 mm
(B) 200 mm
(C) 300 mm
(D) 350 mm

Q.No. 9 A helical gear with 20° pressure angle and 30° helix angle mounted at the mid-span of a shaft that is supported between two bearings at the ends. The nature of the stresses induced in the shaft is

(A) normal stress due to bending only
(B) normal stress due to bending in one plane and axial loading; shear stress due to torsion
(C) normal stress due to bending in two planes and axial loading; shear stress due to torsion
(D) normal stress due to bending in two planes; shear stress due to torsion

Q.No. 10 The crystal structure of γ iron (austenite phase) is

(A) BCC
(B) FCC
(C) HCP
(D) BCT

Q.No. 11 Match the following.

Heat treatment process	Effect
P: Tempering	1. Strengthening
Q: Quenching	2. Toughening
R: Annealing	3. Hardening
S: Normalizing	4. Softening

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

Q.No. 12 The base of a brass bracket needs rough grinding. For this purpose, the most suitable grinding wheel grade specification is

(A) C30Q12V
(B) A50G8V
(C) C90J4B
(D) A30D12V

Q.No. 13 In the Critical Path Method (CPM), the cost-time slope of an activity is given by

(A) $\dfrac{\text{Crash Cost} - \text{Normal Cost}}{\text{Crash Time}}$

(B) $\dfrac{\text{Normal Cost}}{\text{Crash Time} - \text{Normal Time}}$

(C) $\dfrac{\text{Crash Cost}}{\text{Crash Time} - \text{Normal Time}}$

(D) $\dfrac{\text{Crash Cost} - \text{Normal Cost}}{\text{Normal Time} - \text{Crash Time}}$

Q.No. 14 Froude number is the ratio of

(A) buoyancy forces to viscous forces

(B) inertia forces to viscous forces

(C) buoyancy forces to inertia forces

(D) inertia forces to gravity forces

Q.No. 15 Match the following non-dimensional numbers with the corresponding definitions:

Non-dimensional number		**Definition**	
P	Reynolds number	**1**	$\dfrac{\text{Buoyancy force}}{\text{Viscous force}}$
Q	Grashof number	**2**	$\dfrac{\text{Momentum diffusivity}}{\text{Thermal diffusivity}}$
R	Nusselt number	**3**	$\dfrac{\text{Inertia force}}{\text{Viscous force}}$
S	Prandtl number	**4**	$\dfrac{\text{Convective heat transfer}}{\text{Conduction heat transfer}}$

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

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

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

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

Q.No. 16 The velocity field of an incompressible flow in a Cartesian system is represented by

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

Which one of the following expressions for v is valid?

(A) $-4xz + 6xy$

(B) $-4xy - 4xz$

(C) $4xz - 6xy$

(D) $4xy + 4xz$

Q.No. 17 For an ideal gas, the value of the Joule-Thomson coefficient is

(A) positive

(B) negative

(C) zero

(D) indeterminate

Q.No. 18 For an ideal gas, a constant pressure line and a constant volume line intersect at a point, in the Temperature (T) versus specific entropy (s) diagram. C_P is the specific heat at constant pressure and C_V is the specific heat at constant volume. The ratio of the slopes of the constant pressure and constant volume lines at the point of intersection is

(A) $\frac{C_P - C_V}{C_P}$

(B) $\frac{C_P}{C_V}$

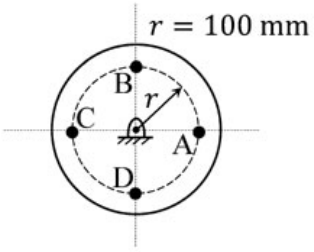
(C) $\frac{C_P - C_V}{C_V}$

(D) $\frac{C_V}{C_P}$

Q.No. 19 For three vectors $\vec{A} = 2\hat{j} - 3\hat{k}$, $\vec{B} = -2\hat{\imath} + \hat{k}$ and $\vec{C} = 3\hat{\imath} - \hat{j}$, where $\hat{\imath}$, $\hat{j}$ and $\hat{k}$ are unit vectors along the axes of a right-handed rectangular/Cartesian coordinate system, the value of $\left(\vec{A} \cdot \left(\vec{B} \times \vec{C}\right) + 6\right)$ is _____.

Q.No. 20 A flywheel is attached to an engine to keep its rotational speed between 100 rad/s and 110 rad/s. If the energy fluctuation in the flywheel between these two speeds is 1.05 kJ then the moment of inertia of the flywheel is _____ kg.m^2 (*round off to 2 decimal places*).

Q.No. 21 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 gets detached then the magnitude of the resultant unbalance force on the rotor is _____ N (*round off to 2 decimal places*).

Q.No. 22

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 stock hardness of the sheet metal increases to 400 HRC, the clearance between the punch and the die should be _____ mm.

Q.No. 23 A company is hiring to fill four managerial vacancies. The candidates are five men and three women. If every candidate is equally likely to be chosen then the probability that at least one woman will be selected is _____(*round off to 2 decimal places*).

Q.No. 24 The compressor of a gas turbine plant, operating on an ideal intercooled Brayton cycle, accomplishes an overall compression ratio of 6 in a two-stage compression process. Intercooling is used to cool the air coming out from the first stage to the inlet temperature of the first stage, before its entry to the second stage. 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 (*round off to 2 decimal places*).

Q.No. 25 In a concentric tube counter-flow heat exchanger, hot oil enters at 102°C and leaves at 65°C. Cold water enters at 25°C and leaves at 42°C. The log mean temperature difference (LMTD) is _____ °C (*round off to one decimal place*).

Q26 - Q55 carry two marks each.

Q.No. 26 The evaluation of the definite integral $\int_{-1}^{1.4} x|x|\,dx$ by using Simpson's 1/3rd (one-third) rule with step size $h = 0.6$ yields

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

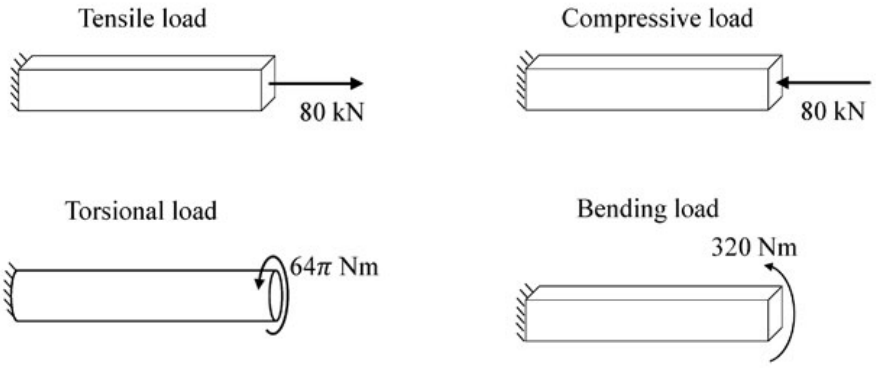
Q.No. 27 A vector field is defined as

$$\vec{f}(x,y,z) = \frac{x}{[x^2+y^2+z^2]^{\frac{3}{2}}}\hat{\imath} + \frac{y}{[x^2+y^2+z^2]^{\frac{3}{2}}}\hat{\jmath} + \frac{z}{[x^2+y^2+z^2]^{\frac{3}{2}}}\hat{k}$$

where, $\hat{\imath}, \hat{\jmath}, \hat{k}$ are unit vectors along the axes of a right-handed rectangular /Cartesian coordinate system. The surface integral $\iint \vec{f}.d\vec{S}$ (where $d\vec{S}$ is an elemental surface area vector) evaluated over the inner and outer surfaces of a spherical shell formed by two concentric spheres with origin as the center, and internal and external radii of 1 and 2, respectively, is

(A) 0
(B) 2π
(C) 4π
(D) 8π

Q.No. 28 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 the cylindrical bar cross-section diameter is 4 cm. The specimens are loaded as shown in the figure.



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

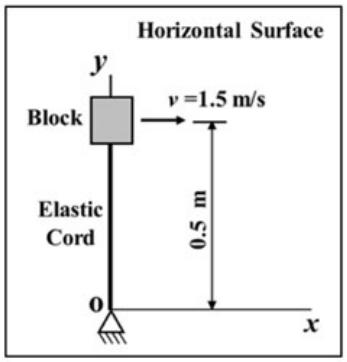
(A) Tensile and compressive load specimens

(B) Torsional load specimen

(C) Bending load specimen

(D) None of the specimens

Q.No. 29 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 5 N/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 is

(A) 0.83

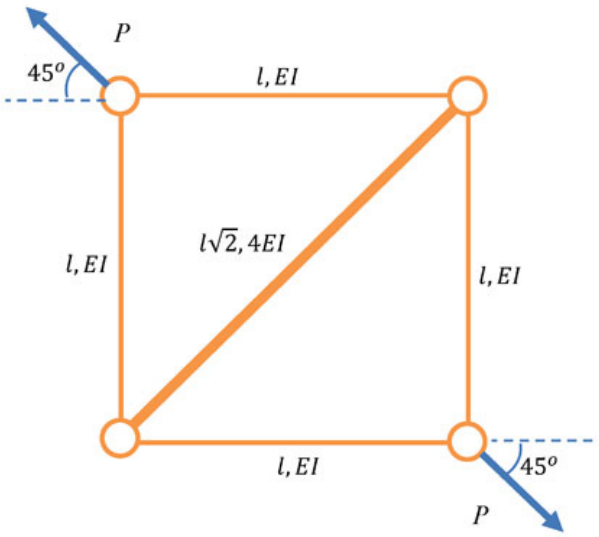
(B) 1.07

(C) 1.36

(D) 1.50

Q.No. 30

The truss shown in the figure has four 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) $\frac{\sqrt{2}\pi^2 EI}{l^2}$

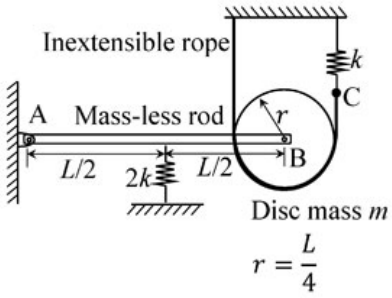
(B) $\frac{\pi^2 EI}{l^2}$

(C) $\frac{2\pi^2 EI}{l^2}$

(D) $\frac{\pi^2 EI}{2l^2}$

Q.No. 31

A rigid mass-less rod of length L is connected to a disc (pulley) of mass m and radius $r = L/4$ through a friction-less revolute joint. The other 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 taut.



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

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

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

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

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

Q.No. 32 A strip of thickness 40 mm is to be rolled to a thickness of 20 mm using a two-high mill having rolls of diameter 200 mm. Coefficient of friction and arc length in mm, respectively are

(A) 0.45 and 38.84

(B) 0.39 and 38.84

(C) 0.39 and 44.72

(D) 0.45 and 44.72

Q.No. 33 For an assembly line, the production rate was 4 pieces per hour and the average processing time was 60 minutes. The WIP inventory was calculated. Now, the production rate is kept the same, and the average processing time is brought down by 30 percent. As a result of this change in the processing time, the WIP inventory

(A) decreases by 25%

(B) increases by 25%

(C) decreases by 30%

(D)

increases by 30%

Q.No. 34 A small metal bead (radius 0.5 mm), initially at 100°C, when placed in a stream of fluid at 20°C, attains a temperature of 28°C in 4.35 seconds. The density and specific heat of the metal are 8500 kg/m^3 and 400 J/kg.K, respectively. If the bead is considered as lumped system, the convective heat transfer coefficient (in W/m^2.K) between the metal bead and the fluid stream is

(A) 283.3

(B)

(C)

(D)

Q.No. 35

Q.No. 36

Q.No. 37

Q.No. 38

Q.No. 39

Q.No. 40

Q.No. 41

Q.No. 42

Q.No. 43

Q.No. 44

Q.No. 45

Q.No. 46

Q.No. 47

Q.No. 48

Q.No. 49

Q.No. 50

Q.No. 51

Q.No. 52

Q.No. 53

Q.No. 54

Q.No. 55