ME: MECHANICAL ENGINEERING

AI25BTECH11011

Q.1 - Q.25 carry one mark each.

1) A streamline and an equipotential line in a flow field
   a) are parallel to each other
   b) are perpendicular to each other
   c) intersect at an acute angle
   d) are identical

(GATE ME 2011)

2) If a mass of moist air in an airtight vessel is heated to a higher temperature, then
   a) specific humidity of the air increases
   b) specific humidity of the air decreases
   c) relative humidity of the air increases
   d) relative humidity of the air decreases

(GATE ME 2011)

3) In a condenser of a power plant, the steam condenses at a temperature of 60°C. The cooling water enters at 30°C and leaves at 45°C. The logarithmic mean temperature difference (LMTD) of the condenser is

   a) 16.2°C b) 21.6°C c) 30°C d) 37.5°C

(GATE ME 2011)

4) A simply supported beam PQ is loaded by a moment of 1 kN-m at the mid-span of the beam as shown in the figure. The reaction forces R_P and R_Q at supports P and Q respectively are

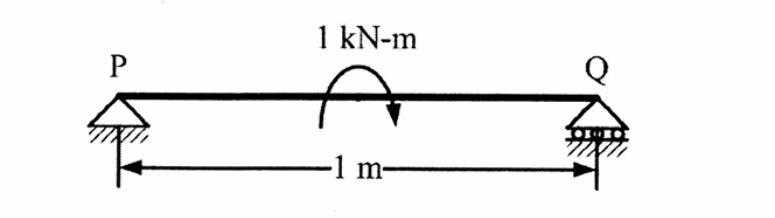


Fig. 4

a) 1 kN downward, 1 kN upward
b) 0.5 kN upward, 0.5 kN downward
c) 0.5 kN downward, 0.5 kN upward
d) 1 kN upward, 1 kN upward

(GATE ME 2011)

5) A double-parallelogram mechanism is shown in the figure. Note that PQ is a single link. The mobility of the mechanism is

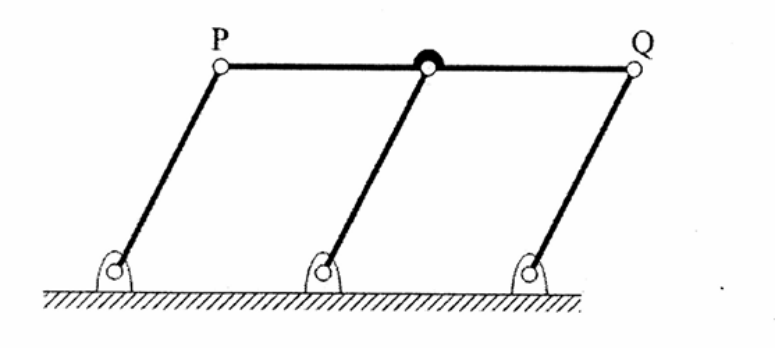


Fig. 5

a) -1 b) 0 c) 1 d) 2

(GATE ME 2011)

6) The maximum possible draft in cold rolling of sheet increases with the
a) increase in coefficient of friction
b) decrease in coefficient of friction
c) decrease in roll radius
d) increase in roll velocity

(GATE ME 2011)

7) The operation in which oil is permeated into the pores of a powder metallurgy product is known as

a) mixing b) sintering c) impregnation d) infiltration

(GATE ME 2011)

8) A hole is of dimension $9^{+0.015}_{+0}$ mm. The corresponding shaft is of dimension $\phi 9^{+0.010}_{+0.001}$ mm. The resulting assembly has

a) loose running fit
b) close running fit
c) transition fit
d) interference fit

(GATE ME 2011)

9) Heat and work are

a) intensive properties
b) extensive properties
c) point functions
d) path functions

(GATE ME 2011)

10) A column has a rectangular cross-section of 10 mm × 20 mm and a length of 1 m. The slenderness ratio of the column is close to

a) 200 b) 346 c) 477 d) 1000

(GATE ME 2011)

11) A series expansion for the function $\sin\theta$ is

a) $1 - \frac{\theta^2}{2!} + \frac{\theta^4}{4!} - \cdots$
b) $\theta - \frac{\theta^3}{3!} + \frac{\theta^5}{5!} - \cdots$
c) $1 + \theta + \frac{\theta^2}{2!} + \frac{\theta^3}{3!} + \cdots$
d) $\theta + \frac{\theta^3}{3!} + \frac{\theta^5}{5!} + \cdots$

(GATE ME 2011)

12) Green sand mould indicates that

a) polymeric mould has been cured
b) mould has been totally dried
c) mould is green in colour
d) mould contains moisture

(GATE ME 2011)

13) What is $\lim_{\theta\to 0} \frac{\sin\theta}{\theta}$ equal to?

a) θ b) $\sin\theta$ c) 0 d) 1

(GATE ME 2011)

14) Eigenvalues of a real symmetric matrix are always

a) positive b) negative c) real d) complex

(GATE ME 2011)

15) A pipe of 25 mm outer diameter carries steam. The heat transfer coefficient between the cylinder and surroundings is 5 W/m^{2}K. It is proposed to reduce the heat loss from the pipe by adding insulation having a thermal conductivity of 0.05 W/mK. Which one of the following statements is **TRUE**?

a) The outer radius of the pipe is equal to the critical radius.
b) The outer radius of the pipe is less than the critical radius.
c) Adding the insulation will reduce the heat loss.
d) Adding the insulation will increase the heat loss.

(GATE ME 2011)

16) The contents of a well-insulated tank are heated by a resistor of 23 Ω in which 10 A current is flowing. Consider the tank along with its contents as a thermodynamic system. The work done by the system and the heat transfer to the system are positive. The rates of heat (Q), work (W) and change in internal energy (ΔU) during the process in kW are

a) $Q = 0,\ W = -2.3,\ \Delta U = +2.3$
b) $Q = +2.3,\ W = 0,\ \Delta U = +2.3$
c) $Q = -2.3,\ W = 0,\ \Delta U = -2.3$
d) $Q = 0,\ W = +2.3,\ \Delta U = -2.3$

(GATE ME 2011)

17) Match the following criteria of material failure, under biaxial stresses σ_1 and σ_2 and yield stress σ_y, with their corresponding graphic representations:

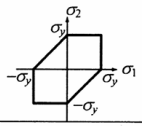
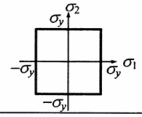
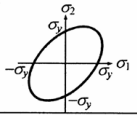
P. Maximum-normal-stress criterion	L. 
Q. Maximum-distortion-energy criterion	M. 
R. Maximum-shear-stress criterion	N. 

Fig. 17

a) P-M, Q-L, R-N
b) P-N, Q-M, R-L
c) P-M, Q-N, R-L
d) P-N, Q-L, R-M

(GATE ME 2011)

18) The product of two complex numbers $1 + i$ and $2 - 5i$ is

a) $7 - 3i$
b) $3 - 4i$
c) $-3 - 4i$
d) $7 + 3i$

(GATE ME 2011)

19) Cars arrive at a service station according to Poisson's distribution with a mean rate of 5 per hour. The service time per car is exponential with a mean of 10 minutes. At steady state, the average waiting time in the queue is

a) 10 minutes
b) 20 minutes
c) 25 minutes
d) 50 minutes

(GATE ME 2011)

20) The word **kanban** is most appropriately associated with

a) economic order quantity
b) just-in-time production
c) capacity planning
d) product design

(GATE ME 2011)

21) If $f(x)$ is an even function and a is a positive real number, then $\int_{-a}^{a} f(x)\,dx$ equals

a) 0 b) a c) $2a$ d) $2\int_a^0 f(x)\,dx$

(GATE ME 2011)

22) The coefficient of restitution of a perfectly plastic impact is

a) 0 b) 1 c) 2 d) ∞

(GATE ME 2011)

23) A thin cylinder of inner radius 500 mm and thickness 10 mm is subjected to an internal pressure of 5 MPa. The average circumferential (hoop) stress in MPa is

a) 100 b) 250 c) 500 d) 1000

(GATE ME 2011)

24) Which one among the following welding processes uses non-consumable electrode?

a) Gas metal arc welding
b) Submerged arc welding
c) Gas tungsten arc welding
d) Flux coated arc welding

(GATE ME 2011)

25) The crystal structure of austenite is

a) body centered cubic
b) face centered cubic
c) hexagonal closed packed
d) body centered tetragonal

(GATE ME 2011)

Q.26 to Q.55 carry two marks each.

26) A torque T is applied at the free end of a stepped rod of circular cross-sections as shown in the figure. The shear modulus of the material of the rod is G. The expression for d to produce an angular twist θ at the free end is:

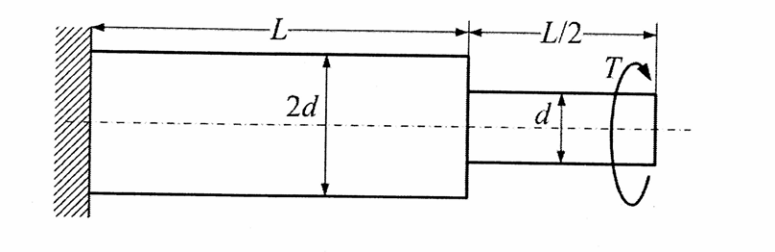


Fig. 26

a) $\left(\frac{32TL}{\pi\theta G}\right)^{\frac{1}{4}}$ b) $\left(\frac{18TL}{\pi\theta G}\right)^{\frac{1}{4}}$ c) $\left(\frac{16TL}{\pi\theta G}\right)^{\frac{1}{4}}$ d) $\left(\frac{2TL}{\pi\theta G}\right)^{\frac{1}{4}}$

(GATE ME 2011)

27) Figure shows the schematic for the measurement of velocity of air (density = 1.2 kg/m^3) through a constant-area duct using a pitot tube and a water-tube manometer. The differential head of water (density = 1000 kg/m^3) in the two columns of the manometer is 10 mm. Take acceleration due to gravity as 9.8 m/s^2. The velocity of air in m/s is:

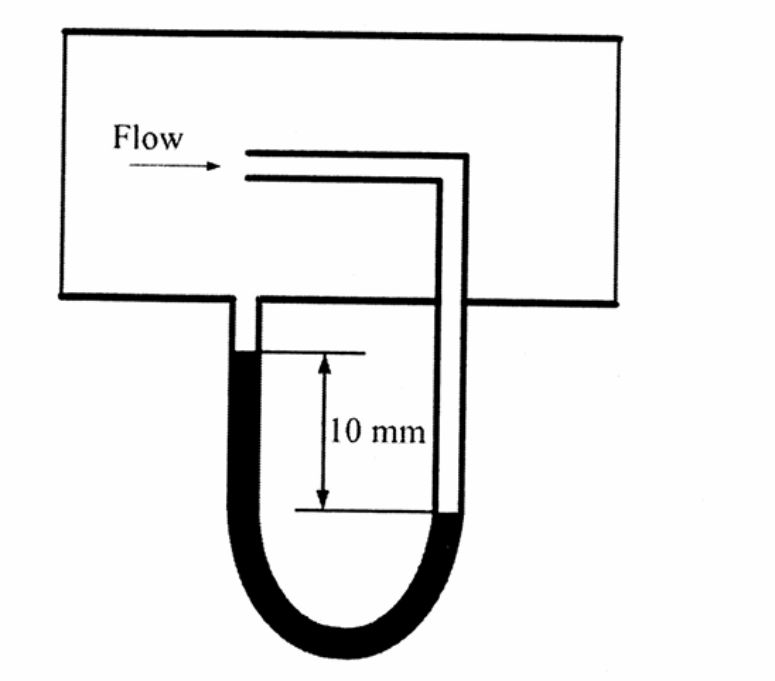


Fig. 27

a) 6.4 b) 9.0 c) 12.8 d) 25.6

(GATE ME 2011)

28) The values of enthalpy of steam at the inlet and outlet of a steam turbine in a Rankine cycle are 2800 kJ/kg and 1800 kJ/kg respectively. Neglecting pump work, the specific steam consumption in kg/kW-hour is:

a) 3.60 b) 0.36 c) 0.06 d) 0.01

(GATE ME 2011)

29) The integral $\int_1^3 \frac{1}{x}\,dx$, when evaluated by using Simpson's 1/3 rule on two equal subintervals each of length 1, equals

a) 1.000 b) 1.098 c) 1.111 d) 1.120

(GATE ME 2011)

30) Two identical ball bearings P and Q are operating at loads 30 kN and 45 kN respectively. The ratio of the life of bearing P to the life of bearing Q is

a) 81/16 b) 27/8 c) 9/4 d) 3/2

(GATE ME 2011)

31) For the four-bar linkage shown in the figure, the angular velocity of link AB is 1 rad/s. The length of link CD is 1.5 times the length of link AB. In the configuration shown, the angular velocity of link CD in rad/s is:

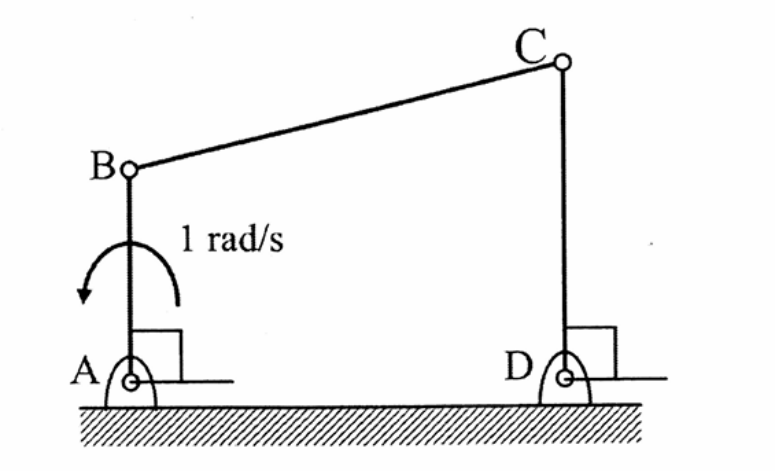


Fig. 31

a) 3 b) $\frac{3}{2}$ c) 1 d) $\frac{2}{3}$

(GATE ME 2011)

32) A stone with mass of 0.1 kg is catapulted as shown in the figure. The total force F_x (in N) exerted by the rubber band as a function of distance x (in m) is given by $F_x = 300x^2$. If the stone is displaced by 0.1 m from the un-stretched position, the energy stored in the rubber band is:

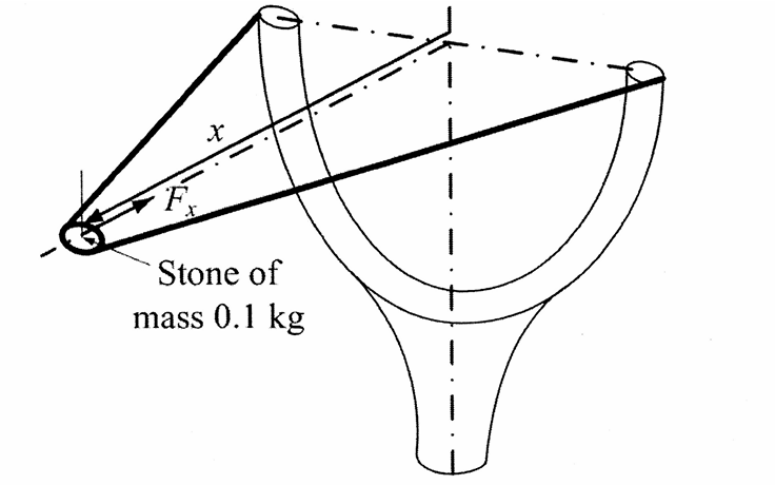


Fig. 32

a) 0.01 J b) 0.1 J c) 1 J d) 10 J

(GATE ME 2011)

33) Consider the differential equation $\frac{dy}{dx} = (1 + y^2)x$. The general solution with constant c is:

a) $y = \tan \frac{x^2}{2} + \tan c$
b) $y = \tan^2\left(\frac{x}{2} + c\right)$
c) $y = \tan^2(\frac{x}{2}) + c$
d) $y = \tan\left(\frac{x^2}{2} + c\right)$

(GATE ME 2011)

34) An unbiased coin is tossed five times. The outcome of each toss is either a head or a tail. The probability of getting at least one head is:

a) $\frac{1}{32}$ b) $\frac{13}{32}$ c) $\frac{16}{32}$ d) $\frac{31}{32}$

(GATE ME 2011)

35) A mass of 1 kg is attached to two identical springs each with stiffness $k = 20$ kN/m as shown in the figure. Under frictionless condition, the natural frequency of the system in Hz is close to:

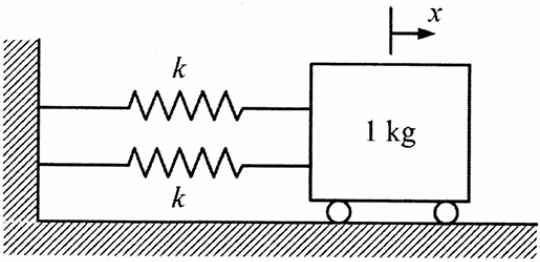


Fig. 35

a) 32 b) 23 c) 16 d) 11

(GATE ME 2011)

36) The shear strength of a sheet metal is 300 MPa. The blanking force required to produce a blank of 100 mm diameter from a 1.5 mm thick sheet is close to:

a) 45 kN b) 70 kN c) 141 kN d) 3500 kN

(GATE ME 2011)

37) The ratios of the laminar hydrodynamic boundary layer thickness to thermal boundary layer thickness of flows of two fluids P and Q on a flat plate are $\frac{1}{2}$ and 2 respectively. The Reynolds number for both flows is 10^4. The Prandtl and Nusselt numbers for P are $\frac{1}{8}$ and 35 respectively. The Prandtl and Nusselt numbers for Q are respectively:

a) 8 and 140 b) 8 and 70 c) 4 and 70 d) 4 and 35

(GATE ME 2011)

38) The crank radius of a single-cylinder I.C. engine is 60 mm and the diameter of the cylinder is 80 mm. The swept volume of the cylinder in cm^3 is:

a) 48 b) 96 c) 302 d) 603

(GATE ME 2011)

39) A pump raises liquid pressure from 1 bar to 30 bar. Density of liquid is 990 kg/m^3. The isentropic specific work done by the pump in kJ/kg is:

a) 0.10 b) 0.30 c) 2.50 d) 2.93

(GATE ME 2011)

40) A spherical steel ball of 12 mm diameter is initially at 1000 K. It is slowly cooled in a surrounding of 300 K. Heat transfer coefficient is 5 W/m^2K, and thermal conductivity of steel is 20 W/mK. The temperature difference between the centre and surface of the ball is:

a) Large because conduction resistance is far higher than convective resistance
b) Large because conduction resistance is far less than convective resistance
c) Small because conduction resistance is far higher than convective resistance
d) Small because conduction resistance is far less than convective resistance

(GATE ME 2011)

41) An ideal Brayton cycle operates between the pressure limits of 1 bar and 6 bar, has minimum and maximum temperatures 300 K and 1500 K. The ratio of specific heats of the working fluid is 1.4. The approximate final temperatures in Kelvin at the end of compression and expansion are respectively

a) 500 and 900 b) 900 and 500 c) 500 and 500 d) 900 and 900

(GATE ME 2011)

42) A disc of mass m is attached to a spring of stiffness k as shown in the figure. The natural frequency of vibration of the system is:

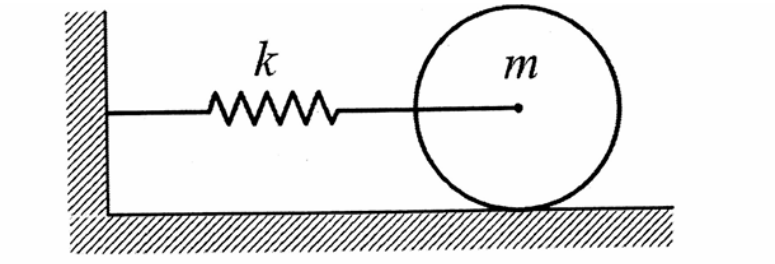


Fig. 42

a) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$ b) $\frac{1}{2\pi}\sqrt{\frac{2k}{m}}$ c) $\frac{1}{2\pi}\sqrt{\frac{2k}{3m}}$ d) $\frac{1}{2\pi}\sqrt{\frac{3k}{2m}}$

(GATE ME 2011)

43) A 1 kg block resting on a surface with coefficient of friction $\mu = 0.1$. A force of 0.8 N is applied to the block as shown in the figure. The friction force is:

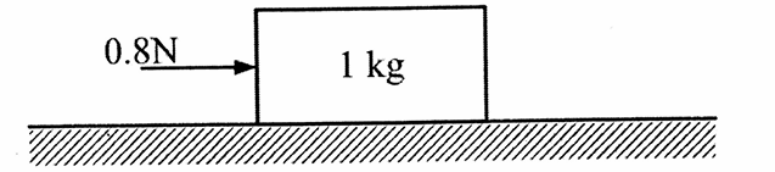


Fig. 43

a) 0 b) 0.8 N c) 0.98 N d) 1.2 N

(GATE ME 2011)

44) Consider the system of equations:
$2x_1 + x_2 + x_3 = 0$,
$x_2 - x_3 = 0$,
$x_1 + x_2 = 0$.
This system has

a) a unique solution
b) no solution
c) infinite number of solutions
d) five solutions

(GATE ME 2011)

45) A single-point cutting tool with 12° rake angle is used to machine a steel workpiece. The depth of cut is 0.81 mm. The chip thickness under orthogonal machining condition is 1.8 mm. The shear angle is approximately

a) 22° b) 26° c) 56° d) 76°

(GATE ME 2011)

46) Match the following non-traditional machining processes with the corresponding material removal mechanisms:

Machining process	Mechanism of material removal
P. Chemical machining	1. Erosion
Q. Electro-chemical machining	2. Corrosive reaction
R. Electro-discharge machining	3. Ion displacement
S. Ultrasonic machining	4. Fusion and vaporiazation

a) P-2, Q-3, R-4, S-1
b) P-3, Q-2, R-4, S-1
c) P-2, Q-4, R-3, S-1
d) P-2, Q-3, R-1, S-4

(GATE ME 2011)

47) A cubic casting of 50 mm side undergoes volumetric solidification shrinkage and contraction of $4\%and6\%$ respectively. No riser is used. Assume uniform cooling in all directions. The side of the cube after solidification and contraction is

a) 48.32 mm b) 49.90 mm c) 49.94 mm d) 49.96 mm

(GATE ME 2011)

Common Data Questions

Common Data for Questions 48 and 49:

In an experimental set-up, air flows between two stations P and Q adiabatically. The direction of flow depends on the pressure and temperature conditions maintained at P and Q. The conditions at station P are: $P_P = 150\,\text{kPa}$ and $350\,\text{K}$ The temperature at station Q is: $T_Q = 300\,\text{K}$.

The following are the properties and relations pertaining to air:
Specific heat at constant pressure, $c_p = 1.005\,\text{kJ/kg·K}$,
Specific heat at constant volume, $c_v = 0.718\,\text{kJ/kg·K}$,
Characteristic gas constant, $R = 0.287\,\text{kJ/kg·K}$
Enthalpy, $h = c_pT$,
Internal energy, $u = c_vT$.

48) If the air has to flow from station P to station Q, the maximum possible value of pressure in kPa at station Q is close to:

a) 50
b) 87
c) 128
d) 150

(GATE ME 2011)

49) If the pressure at station Q is 50 kPa, the change in entropy $(s_Q - s_P)$ in kJ/kgK is:

a) −0.155
b) 0
c) 0.160
d) 0.355

(GATE ME 2011)

Common Data for Questions 50 and 51:

One unit of product P1 requires 3 kg of resource R1 and 1 kg of resource R2. One unit of product P2 requires 2 kg of resource R1 and 2 kg of resource R2. The profits per unit by selling product P1 and P2 are Rs. 2000 and Rs. 3000 respectively. The manufacturer has 90 kg of resource R1 and 100 kg of resource R2.

50) The unit worth of resource R2, i.e. dual price of resource R2 in Rs. per kg is

a) 0
b) 1350
c) 1500
d) 2000

(GATE ME 2011)

51) The manufacturer can make a maximum profit of Rs.

a) 60000
b) 135000
c) 150000
d) 200000

(GATE ME 2011)

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53:

A triangular-shaped cantilever beam of uniform-thickness is shown in the figure. The Young's modulus of the material of the beam is E. A concentrated load P is applied at the free end of the beam.

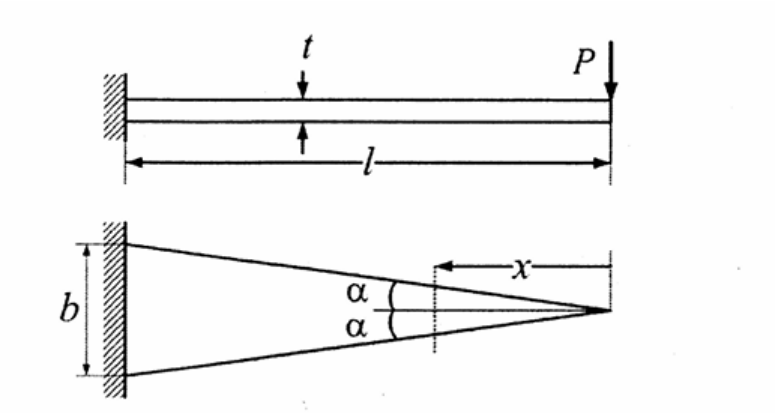


Fig. 51

52) The area moment of inertia about the neutral axis of a cross-section at a distance x measured from the free end is

a) $\frac{bxt^3}{6l}$ b) $\frac{bxt^3}{12l}$ c) $\frac{bxt^3}{24l}$ d) $\frac{xt^3}{12}$

(GATE ME 2011)

53) The maximum deflection of the beam is

a) $\frac{24Pl^3}{Ebt^3}$ b) $\frac{12Pl^3}{Ebt^3}$ c) $\frac{8Pl^3}{Ebt^3}$ d) $\frac{6Pl^3}{Ebt^3}$

(GATE ME 2011)

Statement for Linked Answer Questions 54 and 55:

The temperature and pressure of air in a large reservoir are 400 K and 3 bar respectively. A converging-diverging nozzle of exit area 0.005 m² is fitted to the wall of the reservoir as shown in the figure. The static pressure of air at the exit section for isentropic flow through the nozzle is 50 kPa. The characteristic gas constant and the ratio of specific heats of air are 0.287 kJ/kgK and 1.4 respectively.

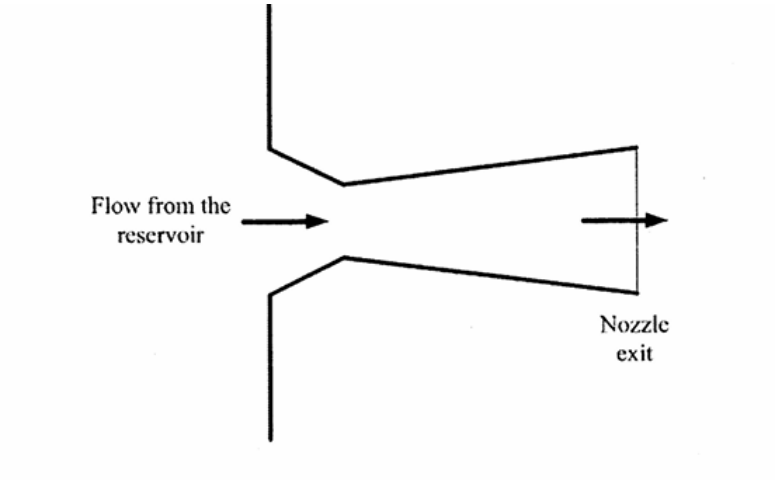


Fig. 53

54) The density of air in kg/m³ at the nozzle exit is

a) 0.560 b) 0.600 c) 0.727 d) 0.800

(GATE ME 2011)

55) The mass flow rate of air through the nozzle in kg/s is

a) 1.30 b) 1.77 c) 1.85 d) 2.06

(GATE ME 2011)

General Aptitude (GA) Questions
Q. 56 - Q. 60 carry one mark each.

56) Choose the word from the options given below that is most nearly opposite in meaning to the given word:
Amalgamate

a) merge
b) split
c) collect
d) separate

(GATE ME 2011)

57) Which of the following options is the closest in the meaning to the word below:
Inexplicable

a) Incomprehensible
b) Indelible
c) Inextricable
d) Infallible

(GATE ME 2011)

58) If $\log(P) = \frac{1}{2}\log(Q) = \frac{1}{3}\log(R)$, then which of the following options is **TRUE**?

a) $P^2 = Q^3R^2$ b) $Q^2 = PR$ c) $Q^2 = R^3P$ d) $R = P^2Q^2$

(GATE ME 2011)

59) Choose the most appropriate word(s) from the options given below to complete the following sentence.

I contemplated ———- Singapore for my vacation but decided against it.

a) to visit
b) having to visit
c) visiting
d) for a visit

(GATE ME 2011)

60) Choose the most appropriate word from the options given below to complete the following sentence.

If you are trying to make a strong impression on your audience, you cannot do so by being understated, tentative or ———-.

a) hyperbolic
b) restrained
c) argumentative
d) indifferent

(GATE ME 2011)

Q. 61 - Q. 65 carry two marks each.

61) A container originally contains 10 litres of pure spirit. From this container 1 litre of spirit is replaced with 1 litre of water. Subsequently, 1 litre of the mixture is again replaced with 1 litre of water and this process is repeated one more time. How much spirit is now left in the container?

a) 7.58 litres b) 7.84 litres c) 7 litres d) 7.29 litres

(GATE ME 2011)

62) **Few school curricula include a unit on how to deal with bereavement and grief, and yet all students at some point in their lives suffer from losses through death and parting.**

Based on the above passage, which topic would not be included in a unit on bereavement?

a) how to write a letter of condolence
b) what emotional stages are passed through in the healing process
c) what the leading causes of death are
d) how to give support to a grieving friend

(GATE ME 2011)

63) P, Q, R and S are four types of dangerous microbes recently found in a human habitat. The area of each circle with its diameter printed in brackets represents the growth of a single microbe surviving human immunity system within 24 hours of entering the body. The danger to human beings varies proportionately with the toxicity, potency and growth attributed to a microbe shown in the figure below:

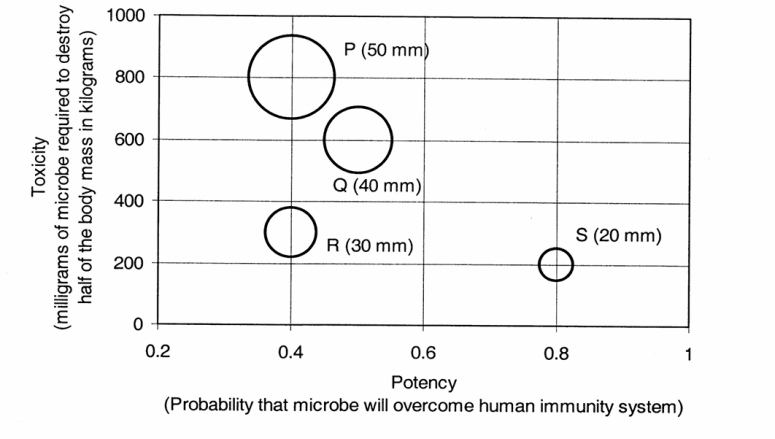


Fig. 63

A pharmaceutical company is contemplating the development of a vaccine against the most dangerous microbe. Which microbe should the company target in its first attempt?

a) P b) Q c) R d) S

(GATE ME 2011)

64) The variable cost (V) of manufacturing a product varies according to the equation $V = 4q$, where q is the quantity produced. The fixed cost (F) of production of the same product reduces with q according to the equation $F = \frac{100}{q}$. How many units should be produced to minimize the total cost $(V + F)$?

a) 5 b) 4 c) 7 d) 6

(GATE ME 2011)

65) A transporter receives the same number of orders each day. Currently, he has some pending orders (backlog) to be shipped. If he uses 7 trucks, then at the end of the 4th day he can clear all the orders. Alternatively, if he uses only 3 trucks, then all the orders are cleared at the end of the 10th day. What is the minimum number of trucks required so that there will be no pending order at the end of the 5th day?

a) 4 b) 5 c) 6 d) 7

(GATE ME 2011)