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Bihar Public Service Commission
Main Examination, 2019
Assistant Engineer

General Paper-VI
Mechanical Engineering

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MECHANICAL ENGINEERING (PAPER-VI)

Q.1 The relationship among elastic modulus (E), modulus of rigidity (G) and Poisson's (ν) is given by

(A) $G = 2E(1 - \nu)$ (B) $G = 2E(1 + \nu)$

(C) $E = 2E(1 - \nu)$ (D) $E = 2E(1 + \nu)$

Ans. (D)

End of Solution

Q.2 The shearing yield strength (S_{sy}) is related to tensile yield strength (S_y) as

(A) $S_{sy} = S_y$ (B) $S_{sy} = 0.414\ S_y$

(C) $S_{sy} = 0.577\ S_y$ (D) $S_{sy} = 0.707\ S_y$

Ans. (C)

End of Solution

Q.3 If a uniform pitch helical compression spring having linear spring stiffness constant *K* is cut in half, the spring constant of either of the resulting two smaller springs will be

(A) 2 K (B) K

(C) K/2 (D) K/4

Ans. (A)

End of Solution

Q.4 For a ductile material, the limiting value of octahedral shear stress (τ_0) is related to the yield stress (S_y) as

(A) $\tau_0 = S_y \dfrac{\sqrt{2}}{3}$ (B) $\tau_0 = S_y 3\sqrt{2}$

(C) $\tau_0 = S_y \dfrac{\sqrt{3}}{2}$ (D) None of the above

Ans. (A)

According to Von-Mises (Theory of failure)

$(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2 = 2\sigma^2_{yield}$ ...(1)

The octachedral shear stress can be given by the expression,

$$\tau_{ys} = \frac{1}{3}\sqrt{(\sigma_1-\sigma_2)^2 + (\sigma_2-\sigma_3)^2 + (\sigma_3-\sigma_1)^2} \quad ...(2)$$

from eq. (1) and (2)

$$\tau_{ys} = \frac{1}{3}\sqrt{2\sigma^2_{yield}}$$

$$\tau_{ys} = \frac{\sqrt{2}}{3}\sigma_{yield}$$

End of Solution

Q.5 The weight percentage of carbon in cementite is

(A) 13.00% (B) 6.67%

(C) 4.00% (D) 0.40%

Ans. (B)

Weight % of carbon in cementite = $\frac{12\times100}{3\times56+12}$ = 6.667%

End of Solution

Q.6 Which of the following does not aid in graphitization of cementite?

(A) Presence of Si (B) Presence of Al

(C) Presence of Ni (D) Low temperature

Ans. (D)

End of Solution

Q.7 Which of the following phases exhibits highest solid solubility of carbon?

(A) Delta iron (B) Gamma iron (austenite)

(C) Alpha iron (D) Ferrite

Ans. (B)

End of Solution

Q.8 The eutectic percentage of carbon in iron is

(A) 0.025% (B) 0.15%

(C) 2.03% (D) 4.33%

Ans. (D)

At eutectic point,

$$\text{Liquid} \xrightleftharpoons[1150^\circ C,\,4.33\%\,C]{\text{On cooling}} \underbrace{\gamma-\text{Iron}+Fe_3C}_{\text{Ledeburite}}$$

End of Solution

Q.9 The eutectic of austenite and cementite is known as

(A) ferrite (B) pearlite

(C) ledeburite (D) austenite

Ans. (C)

End of Solution

Q.10 The limitations of plain carbon steels include

(A) poor hardenability (B) major loss of hardness on tempering

(C) low corrosion resistance (D) all of the above

Ans. (D)

End of Solution

Q.11 The supersaturated interstitial solid solution of carbon in alpha iron is known as
(A) martensite (B) pearlite
(C) bainite (D) ferrite

Ans. (A)
The supersaturated interstitial solid solution of carbon in α-iron is known as martensite.

End of Solution

Q.12 The resultant microstructure after normalizing should be
(A) martensitic (B) pearlitic
(C) bainitic (D) ferritic

Ans. (B)

End of Solution

Q.13 Which of the following is the quench media with highest heat transfer equivalent?
(A) Brine (B) Air
(C) Oil (D) Water

Ans. (A)

End of Solution

Q.14 Which of the following is a thermoplastic?
(A) Bakelite (B) Epoxy resins (araldite)
(C) Polypropylene (D) Polyurethanes

Ans. (C)

End of Solution

Q.15 Which of the following is not the function of a cutting fluid?
(A) Removal of heat (B) Lubrication
(C) Protection against corrosion (D) Abrasion of workpiece

Ans. (D)
Function of a cutting fluid:
1. Cooling of the job and the tool.
2. Lubrication at the chip-tool interface.
3. Cleaning the machining zone by washing away the chip particles and debris.
4. Protection of the nascent finished surface.

Abrasion of workpiece is not the function of cutting fluid.

End of Solution

Q.16 Which of the following machining processes involves cutting of a hard workpiece by a soft material?

(A) Turning
(B) Grinding
(C) Electro-discharge machining
(D) Honing

Ans. (B)

End of Solution

Q.17 Which of the following processes cannot be applied for machining of internal gears?

(A) Hobbing
(B) Shaping
(C) Milling
(D) Broaching

Ans. (A)

Gear hobbing cannot generate internal gears and cannot perform machining of gears.

End of Solution

Q.18 The purpose of applying flux coating on AC arc welding electrode includes

(A) maintaining continuity of arc
(B) protection against corrosion
(C) removal of impurities
(D) all of the above

Ans. (D)

The purpose of applying flux coating on AC arc welding electrode is for maintaining continuity of arc, a protection against corrosion and removal of impurities.

End of Solution

Q.19 The correct sequence of operations for hole making is

(A) centering, boring, drilling, reaming
(B) centering, drilling, boring, reaming
(C) reaming, drilling, centering, boring
(D) boring, drilling, reaming, centering

Ans. (B)

End of Solution

Q.20 The correct sequence of operations for making alloy steel gears is

(A) turning, hobbing, heat treatment, shaving
(B) heat treatment, turning, hobbing, shaving
(C) shaving, hobbing, turning, heat treatment
(D) turning, hobbing, shaving, heat treatment

Ans. (D)

End of Solution

Q.21 The correct sequence of operations for machining a precise rectangular window in a through-hardening die steel workpiece is

(A) heat treatment, surface grinding, drilling, wire EDM
(B) drilling, wire EDM, heat treatment, surface grinding
(C) drilling, heat treatment, surface grinding, wire EDM
(D) surface grinding, heat treatment, wire EDM, drilling

Ans. (B)

The correct sequence of operations for machining a precise rectangular window in a through hardening die steel workpiece.
Drilling, wire EDM, heat treatment, surface grinding.

End of Solution

Q.22 The correct sequence in increasing hardness of tool materials is

(A) HSS, tungsten carbide, cubic boron nitride, diamond
(B) HSS, cubic boron nitride, tungsten carbide, diamond
(C) cubic boron nitride, HSS, tungsten carbide, diamond
(D) tungsten carbide, cubic boron nitride, HSS, diamond

Ans. (A)

End of Solution

Q.23 CNC machines are best suited, when

(A) production volumes are very high and there is no product variety
(B) holes are to be bored at precise locations
(C) very small production volumes and product varieties are involved, while accuracy requirements are not very stringent
(D) a moderate production volume is combined with a moderate product variety and contoured shapes are to be cut

Ans. (A)

End of Solution

Q.24 Which of the following screw threads does not have a symmetric section?

(A) Buttress (B) Square
(C) Whitworth (D) Acme

Ans. (A)

Buttress threads does not have symmetric section.

End of Solution

Q.25 Which of the following is a wrong statement?

(A) Key is generally used for transmitting rotational motion

(B) Cotter is generally employed for transmitting axial motion

(C) The keys are loaded in shear

(D) The cotters have to withstand tensile or compressive loads.

Ans. (D)

The cotter have to withstand double shear and bending failure.

End of Solution

Q.26 When a belt happens to start slipping

(A) it can no longer transmit any power as kinetic friction is less than static friction

(B) It will still continue to transmit power with some slipping

(C) power transmission efficiency will increase

(D) flat belts do not slip

Ans. (B)

End of Solution

Q.27 The tight and slack sides of a belt connecting two pulleys are having tensions of 25 N and 15 N respectively, while the belt is running at 10 m/s. The power transmitted as

(A) 250 W

(B) 150 W

(C) 100 W

(D) Data provided is insufficient for calculating power

Ans. (C)

$$\text{Power} = (T_2 - T_1) \times V = (25 - 15) \times 10$$
$$= 100 \text{ Watt}$$

End of Solution

Q.28 Compared to a belt drive, a chain drive is generally characterized by

(A) constant velocity ratio (B) absence of slip

(C) heavier construction (D) all of the above

Ans. (D)

Chain drive is positive drive. It maintains constant velocity ratio. It has pure rolling motion. In case of positive drive there is no slipping means no energy loss.

End of Solution

Q.29 Which of the following bearings are most suitable for supporting high axial thrust?

(A) Radial ball bearings (B) Needle bearings

(C) Cylindrical roller bearings (D) Tapered roller bearings

Ans. (D)

End of Solution

Q.30 A material store comprises of three 2-sided aisles, each having a length and height corresponding to 50 and 15 storage compartments. The total storage capacity will be

(A) 9000 compartments
(B) 4500 compartments
(C) 3500 compartments
(D) 2500 compartments

Ans. (B)

Capacity = 2 × 3 × 50 × 15 = 4500 compartments

End of Solution

Q.31 Which of the following is a wrong statement?

(A) PERT is suitable for projects having probabilistic time estimates
(B) CPM is suitable for projects having deterministic activities
(C) Both PERT and CPM are event oriented
(D) PERT is event oriented, while CPM is activity oriented

Ans. (C)

End of Solution

Q.32 While solving a linear programming model, if a redundant constraint is added, then what will be its effect on existing solution?

(A) There will be no effect
(B) The solution space will get further constrained
(C) The solution space becomes concave
(D) The problem no longer remains solvable

Ans. (A)

Constraint which does not become part of the boundary making a feasible region is termed as redundant constraint. Inclusion or exclusion of such constraint does not have any effect on the optimum solution of the problem.

End of Solution

Q.33 Which of the following is the plant layout suitable for making heavy equipment, such as ships?

(A) Process layout
(B) Product layout
(C) Fixed position layout
(D) Combination layout

Ans. (C)

End of Solution

Q.34 The term 'jockeying' in queuing theory refers to

(A) not entering the long queue
(B) leaving the queue
(C) shifting from one queue to another parallel queue
(D) none of the above

Ans. (C)

When a customer keep on changing queue in hope to get service faster is known as jockeying in queuing theory.

End of Solution

Q.35 In Klein's construction for reciprocating engine mechanism, the scale of acceleration diagram will be

(A) linear scale of configuration diagram

(B) linear scale of configuration diagram multiplied by square of angular velocity of crank

(C) square of the linear scale of configuration diagram

(D) square of the linear scale of configuration diagram multiplied by square of angular velocity of crank

Ans. (B)

End of Solution

Q.36 A piston having mass $m = 3$ kg executes pure simple harmonic motion, whose displacement in meters is given by $x = 0.05 \sin(10\,t)$. Its inertia force at time $t = 0$ will be

(A) 0 N (B) – 0.15 N

(C) – 1.5 N (D) – 15 N

Ans. (A)

$$m = 3 \text{ kg}$$

$$x = 0.05\sin(10t) \text{ meter}$$

$$\dot{x} = 0.05 \times 10\cos(10t)$$

$$\ddot{x} = -0.05 \times 10 \times 10\sin(10t)$$

Inertia force, $F = m\ddot{x}$

$$= -3 \times 0.05 \times 100\sin(10t)$$

At time, $t = 0$ second

$$F = 0 \text{ N}$$

End of Solution

Q.37 A cam displaces its follower by 20 mm through simple harmonic motion (SHM). The cam is rotating at 15 RPM and its angle of rise is 90°. The time period of the SHM will be

(A) 4 seconds (B) 2 seconds

(C) 1 seconds (D) 0.5 second

Ans. (C)

Outstroke angle

$$\theta_0 = 90^\circ = \frac{90\pi}{180} = \frac{\pi}{2} \text{ rad}$$

Angular velocity of CAM

$$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 15}{60} = \frac{2\pi}{4} = \frac{\pi}{2} \text{ rad/s} \qquad (N = 15 \text{ rpm})$$

Outstroke time

$$t_o = \frac{\theta_o}{\omega} = \frac{\pi/2}{\pi/2} = 1 \text{ second}$$

End of Solution

Q.38 If a flywheel having mass of 100 kg and radius of gyration 10 cm is rotating at 10 rad/s, its rotational kinetic energy will be

(A) 10 J (B) 25 J
(C) 50 J (D) 100 J

Ans. (C)

m = 100 kg, k = 10 cm = 0.1 m, ω = 10 rad/s

$$(KE) = \frac{1}{2}I\omega^2 = \left(\frac{1}{2}\right)mk^2\omega^2$$

$$(KE) = \frac{1}{2}\times 100\times 0.1^2\times 10^2 = 50 \text{ J}$$

End of Solution

Q.39 Calculate the critical sped of a lightweight, vertically mounted shaft carrying a rotor of mass 200 g at its mid-point. The stiffness of shaft at the location stiffness is 72000 N/m.

(A) 360 rad/s (B) 19 rad/s
(C) 360000 rad/s (D) 600 rad /s

Ans. (D)

$m = 200 \times 10^{-3}$ kg
$k = 72000$ N/m

$$\omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{72000}{200\times 10^{-3}}} = \sqrt{360\times 10^3} = 600 \text{ rad/s}$$

End of Solution

Q.40 Which of the following is a correct statements?

(A) A flywheel regulates speed during one cycle while the governor regulates speed from cycle to cycle
(B) The flywheel is an essential element of every prime mover
(C) A flywheel controls the quantity or quality of the working agent
(D) A governor regulates speed by storing kinetic energy

Ans. (A)

End of Solution

Q.41 The secondary force in a crank piston mechanism

(A) arises due to obliquity of connecting rod
(B) acts at double the frequency as that of the primary force
(C) is smaller in magnitude than the primary force
(D) all of the above

Ans. (D)

End of Solution

Q.42 When a system is subjected to forced vibrations, then under steady-state conditions
(A) it vibrates at its natural frequency
(B) it vibrates at the imposed frequency
(C) it vibrates at the mean of natural and imposed frequencies
(D) none of these

Ans. (B)

End of Solution

Q.43 The problem of interference in an involute pinion, which has to come in external mesh with a gear, can be avoided by
(A) increasing the pressure angle
(B) positive profile correction on pinion and corresponding negative profile correction on gear
(C) machining the pinion teeth through hobbing so that the interfering portion gets undercut
(D) all of the above

Ans. (D)

End of Solution

Q.44 The minimum recommended top land for hardened gears in terms of module m is
(A) $0m$ (B) $0.4m$
(C) $1m$ (D) $1.2m$

Ans. (B)

Q.45 Which of the following characteristics is generally exhibited by brittle materials?
(A) High impact strength
(B) Ultimate compressive strength higher than ultimate tensile strength
(C) Good fracture toughness
(D) All of the above

Ans. (B)

End of Solution

Q.46 Consider a plane stress case, where σ_x = 3 Pa, σ_y = 1 Pa and τ_{xy} = 1 Pa. One of the principal directions w.r.t. x-axis would be
(A) 0° (B) 15°
(C) 22.5° (D) 45°

Ans. (C)

σ_x = 3 Pa, σ_y = 1 Pa, τ_{xy} = 1 Pa

$$\tan 2\theta = \frac{2\tau_{xy}}{\sigma_x - \sigma_y} = \frac{2\times 1}{3-1} = 1$$

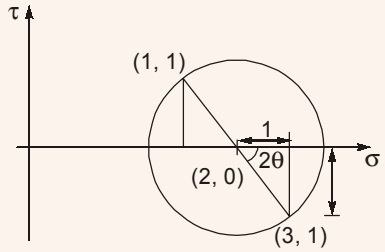
$$\tan 2\theta = \tan 45^\circ$$

$$\theta = 22.5^\circ$$

Alternate:

$$\tan 2\theta = \frac{1}{1} = \tan 45°$$

$$\theta = 22.5°$$



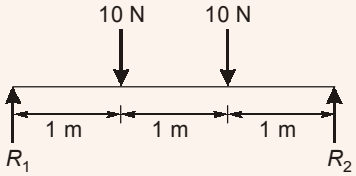
End of Solution

Q.47 A 3 m long beam, simply supported at both ends, carries two equal loads of 10 N each at a distance of 1 m and 2 m from one end. The shear force at the mid-point would be

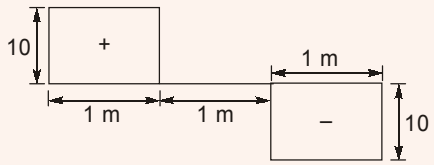
(A) 0 N (B) 5 N

(C) 10 N (D) 20 N

Ans. (A)



By symmetyry, $R_1 = R_2 = 10$ N



Hence shear force at midpoint is zero.

End of Solution

Q.48 Calculate the bending moment at the mid-point of a 6 m long simply supported beam carrying a 20 N point load at the mid-point.

(A) 20 Nm (B) 30 Nm

(C) 45 Nm (D) 60 Nm

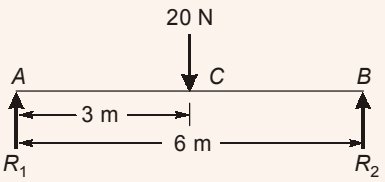
Ans. (B)

By symmetry, $R_1 = R_2 = 10$ N

$(BM)_C = R_1 \times 3$

$= 10 \times 3$

$(BM)_C = 30$ N-m



End of Solution

Q.49 The stress-strain plot for ductile materials exhibits peak at ultimate strength

(A) because necking begins to occur, whereby engineering stress becomes less than the true stress

(B) because the material starts becoming weaking at microstructural level

(C) due to strain softening of the material

(D) none of the above

Ans. (A)

End of Solution

Q.50 For a round shaft subjected to pure torsion, the shear stress at the centre (axis) will be

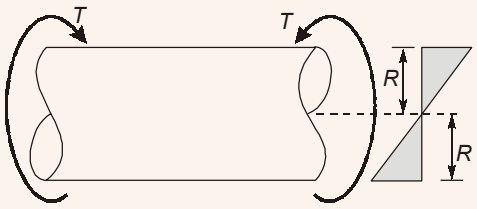
(A) maximum

(B) minimum

(C) zero

(D) the information provided is insufficient

Ans. (C)



$$\frac{T}{I_p} = \frac{\tau}{r} = \frac{G\theta}{L}$$

$$\tau = \frac{T \times r}{I_p}$$

$$\tau_o = \frac{T \times 0}{I_p} = 0$$

Hence shear stress at centre will be zero for round shaft subjected to pure torsion.

End of Solution

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