TEST ID: 312

ACE
Engineering Academy

Head Office : Sree Sindhi Guru Sangat Sabha Association, # 4-1-1236/1/A, King Koti, Abids, Hyderabad - 500001.
Ph: 040-23234418, 040-2324419, 040-2324420, 040-24750437

Hyderabad | Kukatpally | Kothapet | Delhi | Bhopal | Patna | Pune | Bhubaneswar | Lucknow | Bengaluru | Chennai | Vijayawada | Vizag | Tirupati | Kolkata | Ahmedabad

ESE- 2020 (Prelims) - Offline Test Series Test - 24

MECHANICAL ENGINEERING

FULL LENGTH MOCK TEST – 4 _ (PAPER – II) — SOLUTIONS

01. Ans: (d)

Sol: Universal gas constant is same for all gases irrespective of its conditions.

02. Ans: (a)

Sol: For experimentally determining the metacentric height of a ship, we have

Tilting moment caused by the movement of 52.5 kN block by 6 m

= Balancing moment caused by the ship buoyancy

$W' \times x = (W + W') \times Gm \tan\theta$

$$Gm = \frac{W'.x}{(W+W').\tan\theta}$$

Where W' = movable weight on a ship

x = lateral displacement of weight (W')

W = weight of ship alone

θ = angle of tilt

$$\therefore Gm = \frac{52.5\times10^3\times6(m)}{(17.9475\times10^6+52.5\times10^3)\times0.0175}$$

= 1 m

03. Ans: (d)

Sol: Evaporative emissions in SI Engines account for emissions of 25% HC.

04. Ans: (c)

Sol: The return duct is an air conditioning system has a pressure below atmospheric.

05. Ans: (a)

06. Ans: (d)

Sol: Given, $\rho = 0.5$, $\tau = 0.2$,

$\rho + \tau + \alpha = 1$

$\alpha = 0.3$

At thermal equilibrium, $\alpha = \varepsilon$

$\therefore \varepsilon = 0.3$

07. Ans: (d)

Sol: Initial velocity of ball = 10 m/s

$$h = ut - \frac{1}{2}gt^2$$

$$-75 = 10\times t - \frac{1}{2}\times10\times t^2$$

$t^2 - 2t - 15 = 0 \Rightarrow t = 5$ sec

08. Ans: (d)

Sol: Number of basic variables = m + n – 1

= 3 + 3 – 1 = 5

Number of non-basic variables

= (m × n) – 5 = 3 × 3 – 5 = 4

- The transportation problem does not have unbounded solution.
- As the primal is equation constraint, the dual variables of the transportation problem are unrestricted sign.
- To get the optimal solution, number of allocations ≥ (m + n – 1) = 5

09. Ans: (d)

Sol: Stress = $\sigma = E \times \left(\frac{\delta}{\ell}\right)$

Since it is a composite section elongation will be same in both the materials.

$$\frac{\sigma_1}{\sigma_2} = \left(\frac{E_1}{E_2}\right) \times \left(\frac{\ell_2}{\ell_1}\right) = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

10. Ans: (b)

Sol: For conical clutch, engagement and disengagement force,

$$F_{E/D} = W(1 \pm \mu \tan\alpha)$$

11. Ans: (d)

Sol: The microprocessor is generally referred to as the central processing unit (CPU). It is that part of the processor system which processes the data, fetching instructions from memory, decoding them and executing them.

12. Ans: (b)

Sol: In FCC, every corner of the cubic cell and face of the cubic cell, the atoms are present. If inside of the cubic cell also atom present, then it represent BCC.

13. Ans: (a)

Sol: Heat input, Q = CVI

where,

C = fraction of time during which arc is on

$$= \frac{L}{v} = \frac{\text{length of weld}}{\text{welding speed}}$$

$$\frac{Q}{L} = \frac{VI}{v}$$

$$\Rightarrow Q \propto \frac{1}{v}$$

Also, Q ∝ VI

Where, L = length of weld, V = voltage,

I = current, v = welding speed

14. Ans: (c)

Sol: The 'A' weighting filter covers the full frequency range of 20 Hz to 20 kHz, but the shape approximates to the frequency sensitivity of the human ear. So the A-weighted value of a noise source is an approximation to how the human ear perceives the noise.

15. Ans: (a)

Sol: Consider the radial flow velocity at radius r:

$$V_r = \frac{Q}{A_r} = \frac{Q}{\text{Area of hemisphere}}$$

$$V_r = \frac{Q}{2\pi r^2} = \frac{Q}{\frac{\pi d^2}{2}}$$

Radial convective acceleration of radius r

$$(a_r) = V_r \cdot \frac{d(V_r)}{d_r}$$

$$a_r = \frac{Q}{2\pi r^2}\frac{d}{dr}\left(\frac{Q}{2\pi r^2}\right)$$

$$= \frac{Q}{2\pi r^2}\cdot\frac{Q}{2\pi}\cdot\frac{d}{dr}\left(r^{-2}\right)$$

$$= \frac{Q^2}{4\pi^2 .r^2}.(-2)r^{-3} = -\frac{Q^2}{2\pi^2 .r^5}$$

r = 0.1 m

$$a_r = -\frac{\left(300\times\pi\times10^{-6}\right)^2}{2\times\pi^2\times(0.1)^5}$$

$$= -\frac{9\times\pi^2\times10^{-8}\times10^5}{2\times\pi^2\times1} = -4.5\times10^{-3}\,m/s^2$$

Magnitude of radial acceleration

$= +4.5 \text{ mm/sec}^2$

16. Ans: (d)

Sol: Velocity triangles for 50% reaction turbine are congruent hence change in axial velocity is zero. There is no axial thrust due to momentum change but axial thrust is present due to pressure difference across rotor.

17. Ans: (a)

Sol: In simple system the highest dry air rated temperature in the speed range up to 1.2 Mach number.

18. Ans: (c)

19. Ans: (c)

Sol: $I = W_{max} - W_{act}$

$$= 1200 \times \left(1 - \frac{300}{900}\right) - 600$$

$I = 200$ J

20. Ans: (c)

Sol: Heat transfer takes place by flow of hot and cold fluids alternately over a surface in regenerator type heat exchanger.

21. Ans: (d)

Sol: Total radiation (also referred to as global radiation) incident on an inclined surface consists of: (i) beam radiation, (ii) diffuse radiation, and (iii) radiation reflected from ground and surroundings.

22. Ans: (d)

Sol: In case of flitched beams since the materials are bonded rigidly, it is assumed that there is no relative movement between them.

Hence, when the load is applied, materials, will bend together with same radius of curvature. All the assumptions valid in simple bending holds good except that modulus of elasticity is not same throughout the section.

So the stress taken by each material will depend on the modulus of elasticity of the material and are different.

23. Ans: (a)

Sol: The width of the address bus (that is, the number of wires) determines how many unique memory locations can be addressed.

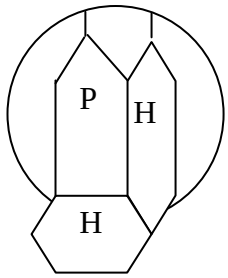
24. Ans: (d)

Sol: The following are classified as non exhaust emission in a carburettor :

- Fuel tank emissions
- Carburettor emissions
- Crank case emissions

25. Ans: (b)

Sol: In C_{60} Fullerene structure contains both hexagons and pentagons with 20 hexagons and pentagons of carbon atom.



26. Ans: (a)

Sol: Grinding is a chip-removal process in which the cutting tool is an individual abrasive grain. The following are major factors that differentiates the action of single grain from that of a single-point cutting tool:

- Conventional abrasive grains have an irregular geometry and are spaced randomly along the periphery of the wheel. Newly developed shaped abrasives are available that provide less random and more aggressive machining surfaces.
- The average *rake angle of the grains is highly negative, typically –60° and lower, thus the shear angles are very low.*
- Depths of cut are very shallow and chips are small and always discontinuous.
- Temperatures are much higher in grinding than in metal cutting; the temperatures can be high enough for some chips to react with oxygen in air, often leading to 'sparks'.
- The grains in the periphery of a grinding wheel have different radial positions from the center of the wheel.
- *The cutting speeds of grinding wheels are very high*, typically on the order of 30 m/s.

27. Ans: (c)

Sol: Apply energy Eq^n between (1) and (2)

$$\left(\frac{P_1}{\rho g}+Z_1+\frac{V_1^2}{2g}\right)=\frac{P_2}{\rho g}+Z_2+\frac{V_2^2}{2g}+h_{loss}$$

Given: $Z_1 = Z_2$; $P_1 - P_2 = 4\rho V^2$

$V_1 = V$, $V_2 = 2V$

$$\therefore h_{LoSS}=\left(\frac{P_1-P_2}{\rho g}\right)+\left(\frac{V_1^2-V_2^2}{2g}\right)$$

$$=\left(\frac{4\rho V^2}{\rho g}\right)+\left(\frac{V^2-4V^2}{2g}\right)$$

$$=\left(\frac{4V^2}{g}\right)+\left(-3\frac{V^2}{2g}\right)$$

$$=\frac{8V^2}{2g}-3\frac{V^2}{2g}$$

$$=\frac{V^2}{2g}(8-3)=5.\frac{V^2}{2g}$$

28. Ans: (b)

Sol: De Laval turbine is a simple single stage impulse turbine.

- Curtis turbine is velocity compounded impulse turbine. As entire pressure is dropped in first stage stator, the pressure in successive rows remains constant.
- Parson's turbine is a reaction turbine with degree of reaction 50%,.

29. Ans: (c)

Sol: $\varepsilon = \dfrac{\text{NTU}}{1+\text{NTU}}$

$$\varepsilon = \frac{2}{1+2} \Rightarrow \varepsilon = \frac{2}{3}$$

30. Ans: (c)

Sol: Sensitivity of isochronous governor is infinity because range of speed is zero. It maintains same speed for different radius.

31. Ans: (a)

Sol: Combustion efficiency in a well adjusted engine varies from 92% - 97%.

32. Ans: (d)

33. Ans: (d)

Sol: A graph of work output versus pressure ratio is a parabolic curve.

34. Ans: (c)

Sol: C'_v = molar heat capacity of the first gas,

C''_v = molar heat capacity of the second gas,

C_v = molar heat capacity of the mixture

and similar symbols for other quantities.

Then $\gamma = \dfrac{C'_p}{C'_v} = 1.67$

and $C'_p = C'_v + R$

This gives $C'_v = \dfrac{3}{2}R$ and $C'_p = \dfrac{5}{2}R$

Similarly, $\gamma = 1.4$ gives

$$C''_v = \frac{5}{2}R \text{ and } C''_p = \frac{7}{2}R$$

Suppose the temperature of the mixture is increased by dT. The increase in the internal energy of the first gas = $n_1\, C'_v\, dT$. The increase in internal energy of the second gas = $n_2 C''_v\, dT$ and the increase in internal energy of the mixture = $(n_1 + n_2)C_v dT$.

Thus,

$$(n_1 + n_2)C_v dT = n_1 C'_v\, dT + n_2 C''_V\, dT$$

Or, $$C_V = \frac{n_1 C'_V + n_2 C''_V}{n_1 + n_2} \quad \text{------ (i)}$$

$$C_P = C_V + R = \frac{n_1 C'_v + n_2 C''_V}{n_1 + n_2} + R$$

$$= \frac{n_1(C'_v + R) + n_2(C''_v + R)}{n_1 + n_2}$$

$$= \frac{n_1 C'_p + n_2 C''_p}{n_1 + n_2} \quad \text{---- (ii)}$$

From (i) and (ii), $\gamma = \frac{C_p}{C_v} = \frac{n_1 C'_p + n_2 C''_p}{n_1 C'_v + n_2 C''_v}$

Putting in the values of C'_P and C''_p

we get $\gamma = 1.54$

35. Ans: (b)

Sol: Fusion powers stars and produces virtually all elements in a process called nucleosynthesis. The Sun is a main-sequence star, and, as such, generates its energy by nuclear fusion of hydrogen nuclei into helium.

36. Ans: (a)

Sol: Principal strains :

$$\varepsilon_{1,2} = \left(\frac{\varepsilon_x + \varepsilon_y}{2}\right) \pm \sqrt{\left(\frac{\varepsilon_x + \varepsilon_y}{2}\right)^2 + \left(\frac{\phi}{2}\right)^2}$$

Occurs at an angle,

$$\tan 2\alpha = \frac{\frac{\phi}{2}}{\frac{\varepsilon_x - \varepsilon_y}{2}}$$

$$\tan 2\alpha = \frac{\phi}{\varepsilon_x - \varepsilon_y}$$

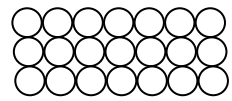
Critical value of 'θ' is the angle at which only linear strains occur, i.e., principal strain.

37. Ans: (d)

Sol: Branch control group includes the instructions that change the sequence of program execution using conditional and unconditional jumps, subroutine, call, return, and restart.

38. Ans: (c)

Sol: **Single crystal:** It is a mono crystalline solid, in which the crystal lattice of the entire sample is continuous, with no grain boundaries.



39. Ans: (a)

Sol: Slush casting is suitable for small production runs, and is generally used for making ornamental and decorative objects (such as lamp bases and stems) and toys from low-melting-point metals such as zinc, tin, and lead alloys.

Plaster-mold Casting, the ceramic-mold and investment casting processes are known as *precision casting*, because of the high dimensional accuracy and good surface finish obtained. Typical parts made are lock components, gears, valves, fittings, tooling, and ornaments.

Shell-molding applications include small mechanical parts requiring high precision, such as gear housings, cylinder heads, and connecting rods.

40. Ans: (d)

Sol: $\delta \propto \frac{x}{\sqrt{Re_x}}$ **(**In laminar boundary)

$\delta \propto \frac{x}{\sqrt{U_\infty . x/\nu}}$ (U and ν are unaltered)

$\delta \propto \frac{x}{\sqrt{x}}$

$\delta \propto \sqrt{x}$

$\therefore \frac{\delta_2}{\delta_1} = \sqrt{\frac{x_2}{x_1}}$

$\delta_2 = \delta_1 . \sqrt{\frac{x_2}{x_1}}$

$\delta_2 = 2.828\sqrt{L/2L}$

$= 2.828 \times \frac{1}{\sqrt{2}} = \frac{2.828}{\sqrt{2}} = 2$ cm

41. Ans: (c)

Sol: Q = 300 W

$Q = \frac{\Delta T}{R}$ ----- (i)

$R = \frac{L_1}{k_1 A} + \frac{L_2}{k_2 A}$

$R = \frac{0.02}{20 \times A} + \frac{0.04}{0.04A}$

$R = \frac{1.001}{A}$

$300 = \frac{(180 - 80)}{\frac{1.001}{A}}$ (from eq.(i))

$\Rightarrow$ A = 3 m^2

42. Ans: (b)

Sol: The ratio of the height of a Porter governor to the height of Watt governor is $\frac{m + M}{M}$.

43. Ans: (c)

Sol: The air box is provided to damp out pulsations.

44. Ans: (d)

Sol: In a cooling tower approach is the difference between exit temperature of water and inlet wet bulb temperature of air.

45. Ans: (a)

Sol: Let initially body of mass 'm_1' is moving with velocity 'v_1' and body of mass 'm_2' is at rest.

a. Initial momentum = $m_1 v_1$
   Final momentum will be zero if both the bodies come to rest so it is not possible.
b. both the bodies may move after collision.
c. It is also possible that the moving body comes to rest and the stationary body starts moving.
d. If the stationary body remains stationary then moving body will change its velocity so momentum conservation fails.

TEST YOUR PREP

IN A REAL TEST ENVIRONMENT

Pre GATE - 2020

Date of Exam : **18th January 2020**
Last Date to Apply : **31st December 2019**

Highlights:

- Get real-time experience of **GATE-20** test pattern and environment.
- Virtual calculator will be enabled.
- Post exam learning analytics and All India Rank will be provided.
- Post **GATE** guidance sessions by experts.
- Encouraging awards for **GATE-20** toppers.

PAN INDIA
PRESENCE AVAILABLE IN MORE THAN
30 CITIES

SSC-JE (Paper-I)

Online Test Series

Staff Selection Commission - Junior Engineer

No. of Tests : 20

Subject Wise Tests : 16 | Mock Tests - 4

Civil | Electrical | Mechanical

AVAILABLE NOW

All tests will be available till **SSC 2019 Examination**

040 - 48539866 / 040 - 40136222 testseries@aceenggacademy.com

46. Ans: (d)

47. Ans: (a)

Sol: Both tracking methods given are used for getting maximum output from the solar PV system.

48. Ans: (b)

Sol: $\sigma_1 = 150\ N/mm^2$ $\sigma_2 = 75\ N/mm^2$

$\sigma_1 = -30\ N/mm^2$ $\mu = 0.3$

Yield stress = $\sigma_y = 300\ N/mm^2$

According to maximum principle stress theory.

$$\sigma_1 = \frac{\sigma_y}{FOS}$$

$$\Rightarrow 150 = \frac{300}{FOS}$$

$$\Rightarrow FOS = 2$$

49. Ans: (a)

Sol: $F_D = 2$ kN,

$L_D = 10^9$ rev,

$R = 0.90$

$$C_{10} = F_D\left(\frac{L_D}{L_R}\right)^{\frac{1}{3}}$$

$$= 2\times\left(\frac{10^9}{10^6}\right)^{\frac{1}{3}} = 20\ kN$$

50. Ans: (d)

Sol: Programmable Logic Controller (PLC) also known as Industrial Computer is the major component in the industrial automation sector.

These are used to connect the sensors and actuator that are of digital in nature, i.e., only for switch ON and OFF purpose.

51. Ans: (d)

Sol: The point to point robots got the capability to travel from one position to another. The desired paths are taught and stored in the control unit memory. These robots do not move from the desired location for controlling its path. It can be moved in a small distance only with the help of programming. This type of robots can be used for *spot welding,* loading & unloading, and drilling operations.

52. Ans: (c)

Sol: Polyvinyl chloride (PVC) is synthetic plastic polymer used for cable insulation.

53. Ans: (a)

Sol: *Molybdenum high-speed steel*: Many high-speed steels use molybdenum as the principal alloying element, since one part will replace two parts of tungsten.

Molybdenum steels such as 6-6-4-2 containing 6% tungsten, 6% molybdenum, 4% chromium and 2% vanadium have *excellent toughness and cutting ability.*

54. Ans: (b)

55. Ans: (a)

Sol: $u = \frac{\pi DN}{60} = \pi \times \frac{3}{\pi} \times \frac{3000}{60} = 150 \text{ m/s}$

$$\rho = \frac{u}{v_1}$$

$$\therefore v_1 = \frac{u}{\rho} = \frac{150}{0.45} = 333.3 \text{ m/s}$$

56. Ans: (b)

Sol: Given data :

$\phi = \frac{\pi}{2}$, h = 30 mm

$\omega = \frac{2\pi \times 300}{60}$ and N = 300 rpm

$$a = \frac{h}{2}\left(\frac{\pi\omega}{\phi}\right)^2$$

$$a = \frac{30}{2}\left[\frac{\pi \times \frac{2\pi \times 300}{60}}{\pi/2}\right]^2$$

$a = 59.217 \text{ m/s}^2$

57. Ans: (b)

Sol: Nusselt number may be characterized as the dimensionless temperature gradient at the surface.

58. Ans: (c)

Sol: Following are the advantages of air cooling system :

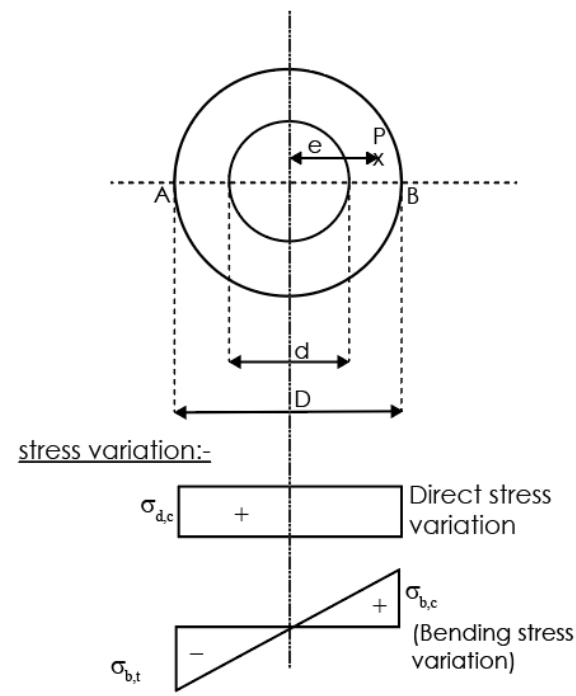
- No freezing trouble
- Less weight

59. Ans: (c)

60. Ans: (d)

61. Ans: (b)

Sol:



Stresses induced in the member

(a) Direct stress $\sigma_d = \frac{P}{A}$ (Compression)

(b) Bending stress, $\sigma_b = \frac{M}{Z} = \frac{Pe}{Z}$

For no tension condition at 'A'

$\sigma_d \geq \sigma_b$

$\frac{P}{A} \geq \frac{P \times e}{Z}$

Area of cross section = $A = \frac{\pi}{4}\left(D^2 - d^2\right)$

Section modulus, $Z = \frac{I}{y}$

$I = \frac{\pi}{64}\left(D^4 - d^4\right)$

$y = \frac{D}{2}$

$\Rightarrow \frac{4P}{\pi\left(D^2 - d^2\right)} \geq \frac{64Pe}{\pi\left(D^4 - d^4\right)} \times \frac{D}{2}$

$\Rightarrow e < \frac{D^2 + d^2}{8D}$

62. Ans: (a)

Sol: SCARA Robot has low compliance in vertical plane.

63. Ans: (b)

Sol: Pure metals have less crystallographic imperfections and hence they have high conductivity and large temperature coefficient.

64. Ans: (d)

Sol: Efficiency of draft tube,

$$\eta = \frac{\frac{V_1^2}{2g} - \left(\frac{V_2^2}{2g} + h_f\right)}{\frac{V_1^2}{2g}}$$

$$= \frac{4 - (0.5 + 0.7)}{4}$$

$$= \frac{4 - 1.2}{4} = \frac{2.8}{4} = 0.7 = 70\%$$

65. Ans: (d)

Sol: For roughing, $20(T_r)^{1/8} = C = 20(T_f)^{1/10}$ for finishing.

where, T_r = tool life for roughing

and T_f = tool life for finishing

hence, $(T_r)^{1/8} = (T_f)^{1/10}$

Or, $(64)^{1/8} = (T_f)^{1/10}$

Hence tool life for finishing $(T_f) = (64)^{\frac{10}{8}}$

$= (64)^{\frac{2.5}{2}} = 8^{2.5}$

$= 8^2 \times 8^{1/2}$

$= 64 \times 2\sqrt{2} = 128\sqrt{2}$

= 181 min

66. Ans: (b)

Sol: Neglecting gas column, pressure along the dotted line = 34 kPa

Gauge pressure in an inclined mano-meter

$P_G = \rho.g.h = \rho_m.g.\ell_m \sin\theta$

$$34000 = 13600 \times 10 \times \ell_m \times \sin 30°$$

$$\ell_m = \frac{34000}{13600 \times 10 \times 0.5}$$

$$= \frac{68000}{136000} = 0.5 \text{ m}$$

67. Ans: (c)

Sol:

- Thermal conductivity of metals decreases with increasing in temperature and increases with decreasing in temperature.
- Thermal conductivity of non-metallic increases with increasing in temperature and decreases with decreasing in temperature.

68. Ans: (a)

Sol: Fuel air ratio and spark advance are the factors that affect engine heat transfer.

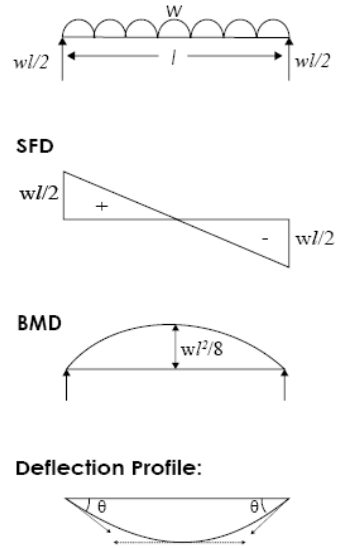
69. Ans: (b)

70. Ans: (c)

Sol: The locus of points indicating the actual condition of steam at exit of each stage is called Line of condition.

71. Ans: (b)

Sol: For a simply supported beam subjected to uniformly distributed loads.



Conclusions:

(i) Bending moment is maximum at centre and zero at support

(ii) Shear force is maximum at supports and zero at centre.

(iii) Slope is maximum at supports and zero at midspan.

72. Ans: (a)

Sol: A control valve is a valve used to control fluid flow by varying the size of the flow passage as directed by a signal from a controller.

73. Ans: (c)

Sol: Constantan is an alloy of 60% Cu and 40% Ni.

74. Ans: (c)

Sol: *Allowance,* also called functional dimension or sum dimension: The specified difference in dimensions between mating parts.

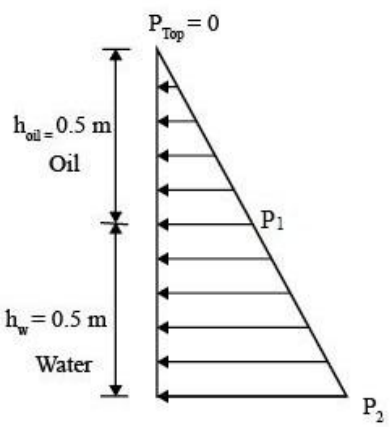
Basic size: Dimension from which limits of size are derived, with the use of tolerances and allowances.

Nominal size: An approximate dimension that is used for the purpose of general identification.

Fit: The range of looseness or tightness that can result from the application of a specific combination of allowance and tolerance in the design of mating-part features.

75. Ans: (c)

Sol: The pressure prism is shown as under:



Hydrostatic force exerted on one of the vertical wall due to water and oil columns

= Area of pressure diagrams × length of volume

= Triangle pressure + Trapezoidal pressure

$$= \left[\frac{1}{2}P_1 \times h_{oil}\right] \times L + \left\{\frac{h_w}{2}\left[P_1 + P_2\right]\right\} L$$

$$= \frac{1}{2} \times \rho_{oil}.g.h_{oil} \times h_{oil} \times L +$$

$$\frac{hw}{2}\left[\left(\rho_{oil}.g.h_{oil}\right) + \left(\rho_{oil}.g.h_{oil} + \rho_w.g.h_w\right)\right] L$$

$$= \frac{1}{2} \times 800 \times 10 \times 0.5 \times 0.5 \times 1 +$$

$$\frac{0.5}{2}\left[800 \times 10 \times 0.5 + 800 \times 10 \times 0.5 + 1000 \times 10 \times 0.5\right] 1$$

$$= (1000) + \frac{0.5}{2}(4000 + 4000 + 5000)$$

$$= 1000 + 0.25(13000)$$

= 4250 N = 4.25 kN

76. Ans: (c)

Sol: Time constant of a thermocouple is the time taken to attain 63.2% of the value of initial temperature difference.

77. Ans: (d)

Sol: Crank case ventilation is provided to remove blowby.

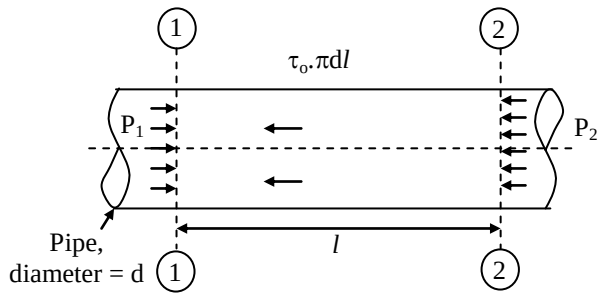
78. Ans: (a)

Sol: In Refrigerator, the mass charged is greater than mass circulated.

79. Ans: (d)

80. Ans: (a)

Sol: Consider a pipe line of length l with pressure difference $(P_1 - P_2)$ as shown in figure.



Equating the net pressure force to the boundary resistance fore

$$(P_1 - P_2).\frac{\pi}{4}d^2 = \tau_o.\pi d\ell$$

$$\therefore P_1 - P_2 = \frac{4\tau_o.\ell}{d}$$

Darcy - Weisbach frictional head

$$\text{loss } (h_f) = \frac{f.\ell.V^2}{2g.d}$$

$$\frac{P_1 - P_2}{\rho g} = \frac{f.\ell.V^2}{2g.d}$$

$$\frac{\frac{4\tau_o.\ell}{d}}{\rho g} = \frac{f.\ell.V^2}{2gd}$$

$$\frac{4\tau_o}{\rho} = \frac{f.V^2}{2}$$

$$\tau_o = \frac{f.\rho.V^2}{8}$$

81. Ans: (b)

Sol: Following are the advantages of indirect injection combustion chambers :

- Low injection pressure
- Direction of spray is not critical

82. Ans: (b)

Sol: Given, d = 0.5 m

T_s = 500 K

T_∞ = 300 K

$h_{combined}$ = 30 W/m^{2}K

$$Q = h_{combined} \times A \times (T_s - T_\infty)$$

$= 30 \times \pi \times 0.5 \times (500 - 300)$

Q = 9.4 kW/m

83. Ans: (a)

Sol: Theoretical amount of O_2 required for complete combustion

= [8/3C + 8(H – O/8) + S]

= [((8/3)*0.9) + 8(0.04 – (0.04/8)) + 0.02]

= 2.4+(8*0.035)+0.02

= 2.4+0.280+0.02

= 2.4+0.300 = 2.7

84. Ans: (c)

Sol: The output of a wind turbine is greatly influenced by the blade pitch angle. Blade pitch control is a very effective way of controlling the output power, speed or torque.

85. Ans: (a)

Sol: According to Indian Standard Institute specification for testing of refrigerators, the environment temperature at 43°C.

86. Ans: (d)

Sol: In hollow thick cylinder subjected only to internal pressure 'P'.

Radial pressure = P at inner most surface and reduces to atmospheric pressure (i.e. = zero) at outer most surface and the variation is given by

$P_x = \frac{b}{x^2} - a$ at any distance 'x' from centre.

87. Ans: (a)

Sol:

- Consider the modern *autofocus, auto-exposure camera*. To use the camera all you need to do is point it at the subject and press the button to take the picture. The camera can automatically adjust the focus so that the subject is in focus and automatically adjust the aperture and shutter speed so that the correct exposure is given. You do not have to manually adjust focusing and aperture or shutter speed controls.
- Consider a *truck smart suspension*. Such a suspension adjusts to uneven loading to maintain a level platform, adjusts to cornering, moving across rough ground, etc., to maintain a smooth ride.
- Consider an *automated production line*. Such a line may involve a number of production processes which are all automatically carried out in the correct sequence and in the correct way with a reporting of the outcomes at each stage in the process. The automatic camera, the truck suspension and the automatic production line are examples of a marriage between electronics, control systems and mechanical engineering.

88. Ans: (c)

Sol: Pearlite is a two-phased, lamellar (or layered) structure composed of alternating layers of ferrite (87.5 wt%) and cementite (12.5 wt%) that occurs in some steels and cast irons. During slow cooling of an iron-carbon alloy, pearlite forms by a eutectoid reaction as austenite cools below 727°C (the eutectoid temperature).

89. Ans: (d)

Sol: In CNC, operations are never manual, neither by hardware and not always by form tools. Operations are computer controlled by combination of axes movements

90. Ans: (c)

Sol:

1. Inertial forces / unit mass

$$a_x = u.\frac{\partial u}{\partial x} + v.\frac{\partial u}{\partial y} + w.\frac{\partial u}{\partial z} + \frac{\partial u}{\partial t}$$

Similarly a_y and a_z

2. Body force / unit mass

x, y and z (If gravity forces only, then g_x, g_y and g_z)

3. Pressure forces / unit mass

$$-\frac{1}{\rho}.\frac{\partial P}{\partial x}, -\frac{1}{\rho}.\frac{\partial P}{\partial y} \text{ and } \frac{-1}{\rho}\frac{\partial P}{\partial z}$$

4. Viscous forces / unit mass

In x-direction,

$$\nu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right)$$

Similarly for y and z directions.

Surface Tension force and Turbulent forces are not considered in Navier-stokes equation.

91. Ans: (b)

Sol: By reducing charge in SI engine, knocking is reduced.

92. Ans: (b)

Sol: Given data:

Mass of reciprocating parts, $m_r = 50$ kg,

Mass of revolving parts, $m_p = 20$ kg,

Percentage of reciprocating parts to be balanced, $c = 0.6$

Stroke, $2r = 300$ mm $\Rightarrow r = 150$ mm

Mass to be balanced at the crank pin

$$= c\, m_r + m_p$$

$$= 0.6\times 50 + 20 = 50 \text{ kg}$$

$m_c r_c = mr$

$m_c \times 100 = 50 \times 150$

$\Rightarrow m_c = 75$ kg

93. Ans: (a)

94. Ans: (c)

95. Ans: (c)

Sol: $(\Delta S)_{block} = \int_{T_1}^{T_2} C\frac{dT}{T} = C\ell n\frac{T_2}{T_1}$

As potential energy of block dissipates into internal energy of lake,

$$\therefore \quad (\Delta S)_{lake} = \frac{gz}{T_2} + \frac{C(T_1 - T_2)}{T_2}$$

$$\Rightarrow (\Delta S)_{universe} = C\ell n\frac{T_2}{T_1} + \frac{gz + C(T_1 - T_2)}{T_2}$$

$$= \frac{C\left[T_2\ell n\frac{T_2}{T_1} + (T_1 - T_2)\right] + gz}{T_2}$$

ACE Engineering Academy
Leading Institute for ESE/GATE/PSUs

HEARTY CONGRATULATIONS TO OUR ESE - 2019 TOP RANKERS

and many more...

TOTAL SELECTIONS in Top 10: 33

(EE: 9, E&T: 8, ME: 9, CE: 7) and many more...

Since 1995
ACE

DIGITAL CLASSES

for

ESE 2020/2021
General Studies &
Engineering Aptitude

GATE 2020/2021
Computer Science &
Information Technology

Access the Course at

www.deep-learn.in

96. Ans: (b)

Sol: Generally, beams have same cross-section throughout. Since the bending moment is not maximum at all sections, cross-section dimensions can be varied along the length to resist BM at that particular section. i.e a non - prismatic beam.

97. Ans: (c)

Sol: $\text{Speed}(\text{RPS}) = \dfrac{\text{PPS}}{\text{Resolution}}$

$\& \ \text{Resolution} = \dfrac{360^\circ}{\theta}$

So, $\text{RPS} = \dfrac{\text{PPS}}{360/\theta} = \dfrac{\text{PPS}}{360} \times \theta$

$$0.25 = \frac{\text{PPS}}{360} \times 7.5^\circ \Rightarrow \text{PPS} = 12$$

98. Ans: (a)

99. Ans: (a)

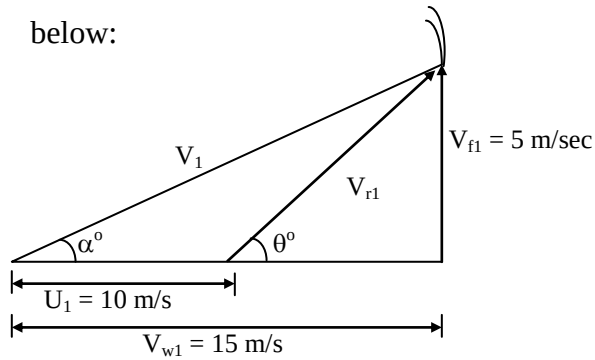
Sol: The maximum possible *draft* is defined as the difference between the initial and final strip thicknesses, or $(h_o - h_f)$; a large draft could cause the rolls to slip. It can be shown that maximum draft is a function of the roll radius, *R*, and the coefficient of friction, μ, as: $h_0 - h_f = \mu^2 R$.

100. Ans: (d)

Sol: Let α° = Guide angle,

θ = Vane angle at inlet

From the inlet velocity triangle as drawn below:



$$\alpha^\circ = \tan^{-1}\left(\frac{V_{f_1}}{V_{w_1}}\right)$$

$$\alpha^\circ = \tan^{-1}\left(\frac{5}{15}\right)$$

$$\alpha^\circ = 18.4^\circ$$

$$\theta^\circ = \tan^{-1}\left(\frac{V_{f_1}}{V_{w_1} - U_1}\right)$$

$$\theta^\circ = \tan^{-1}\left(\frac{5}{15-10}\right)$$

$$\theta^\circ = \tan^{-1}(5/5)$$

$$\Rightarrow \theta^\circ = 45^\circ$$

101. Ans: (c)

Sol: Fuel is injected in a four stroke CI Engine at the end of compression stroke.

102. Ans: (d)

103. Ans: (d)

Sol: Water-Lithium Bromide absorption chillers are available in capacities 100 TR - 7500 TR.

104. Ans: (b)

Sol: In an inherently second order system like mass, spring and damper, there are two elements that store energy namely, mass and spring. Energy dissipation is due to damper or dashpot.

105. Ans: (d)

Sol: Carbon Nano Tubes (CNTs) have low densities and unusual electric properties which are valuable for nanotechnology, optics and electronics. They are ductile and are strongest and stiffest materials yet discovered in terms of tensile strength and elastic modulus respectively.

106. Ans: (b)

Sol: Given data:

No. of jets = 2, P_{shaft} = 11.76 MW,

c_v = 0.98, H = 320 m,

g = 10 m/s^2, a_j = 0.03 m^2

Absolute velocity of each jet,

$$V_1 = c_v\sqrt{2gH} = 0.98\sqrt{2\times10\times320}$$

$$= 0.98\times80 = 78.4 \text{ m/s}$$

Total discharge, $Q = 2\times a_j\times V_1$

$$= 2\times0.03\times78.4$$

$$= 4.704 \text{ m}^3/\text{s}$$

$$\text{Overall efficiency} = \frac{P}{\rho gQH}$$

$$= \frac{11.76\times10^6}{10^3\times10\times4.704\times320}$$

$$= \frac{2.5\times10}{32} = \frac{25}{32} = 0.7813$$

107. Ans: (d)

108. Ans: (c)

Sol: A control system can be thought of as a system which can be used to:

- control some variable to some particular value, e.g. a central heating system where the temperature is controlled to a particular value;
- control the sequence of events, e.g. a washing machine where when the dials are set to, say, 'white' and the machine is then controlled to a particular washing cycle, i.e. sequence of events, appropriate to that type of clothing;
- control whether an event occurs or not, e.g. a safety lock on a machine where it cannot be operated until a guard is in position.

109. Ans: (c)

Sol: Crevice corrosion refers to corrosion occurring in confined spaces to which the access of the working fluid from the environment is limited. These spaces are generally called crevices. Examples of crevices are gaps and contact areas between parts, under gaskets or seals, inside cracks and seams, spaces filled with deposits and under sludge piles. Hence statement(c) is INCORRECT.

110. Ans: (b)

Sol: Given data: N = 300 rpm

Rate of change of angular momentum = 3000 N.m = Torque (T) on the shaft.

$$\text{Power developed} = \frac{2\pi NT}{60}$$

$$= \frac{2\pi \times 300 \times 3000}{60}$$

$$= 30000\pi \text{ W}$$

$$= 30\pi \text{ kW}$$

111. Ans: (b)

Sol: If time constant (τ) of a sensor is high, then its inertia is high.

112. Ans: (a)

Sol: The polar configuration consists of *a telescopic link* (prismatic joint) that can be raised or lowered about a horizontal revolute joint. These two links are mounted on a rotating base. This arrangement of joints, known as *RRP configuration*, gives the capability of moving the arm end-point within a partial spherical shell space as work volume. The spherical configuration consists of two revolute joints and one linear joint (RRP), so that the robot moves in a spherical, or polar, coordinate system.

113. Ans: (d)

Sol: Given data: Kaplan turbine

$d_t = 6$ m, $d_h = 2.5$ m, $H = 10$ m,

$v_f = \frac{24}{\pi}$ m/s, P = 14.28 MW.

The discharge is given by,

$$Q = \frac{\pi}{4}\left(d_t^2 - d_h^2\right)v_f$$

$$= \frac{\pi}{4}\left(6^2 - 2.5^2\right) \times \frac{24}{\pi}$$

$$= 29.75 \times 6 = 178.5 \text{ m}^3/\text{s}$$

Overall efficiency of Kaplan turbine,

$$\eta_o = \frac{P}{\rho g Q H} = \frac{14.28 \times 10^6}{10^3 \times 10 \times 178.5 \times 10}$$

$$= \frac{142.8}{178.5} = 0.8$$

114. Ans: (d)

Sol: Humanoid robots typically have 30 or more degrees of freedom, with six degrees of

freedom per arm, five or six in each leg, and several more in torso and neck.

115. Ans: (c)

116. Ans: (c)

Sol: Metal corrosive to R12 refrigerant is Aluminium.

117. Ans: (a)

Sol: The draught produced in terms of Hot flue gas column is given by $H\left[\frac{m_a}{m_a+1}\times\frac{T_g}{T_a}-1\right]$.

118. Ans: (d)

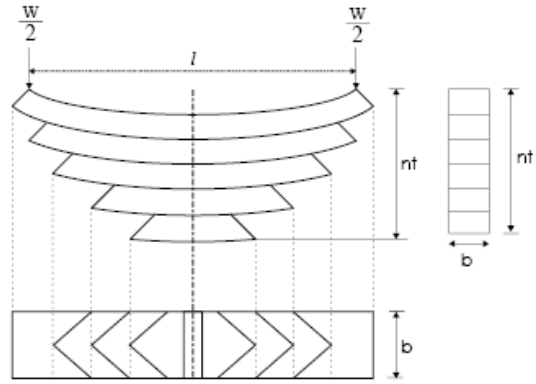
Sol: $u_2=\frac{\pi D_2 N}{60}=\frac{\pi\times 0.8\times 1200}{60}=50.3$ m/s

$P=\dot{m}\mu u_2^2$

$\therefore\ W=\frac{P}{\dot{m}}=\mu u_2^2=0.8\times 50.3^2=2024$ kJ/kg

119. Ans: (d)

Sol:



Laminated springs: These are built up member plates as shown above which are loaded at the ends and supported in the middle, i.e. they are beams of uniform strength and are given an initial curvature so that when the beam is loaded, central deflection disappears and plates becomes flat.

Let '*l*' be the horizontal span of spring comprised of 'n' plates of thickness 't' each.

Bending moment at the centre = $\frac{w\ell}{4}$

$$\sigma=\frac{M}{Z}$$

For single plate section modulus = $\frac{b\times(t)^2}{6}$

For 'n' plate section modulus = $\frac{n\times(bt)^2}{6}$

$$\sigma=\frac{w\ell}{4\frac{nbt^2}{6}}=\frac{3}{2}\frac{WL}{nbt^2}$$

120. Ans: (a)

Sol: The dashpot is represented by a resistor, the spring by a capacitor, and the mass by an inductor.

121. Ans: (a)

Sol: Screw transformation around Z and along Z

$$\begin{bmatrix} \text{Cos}\pi & -\text{Sin}\pi & 0 & 0 \\ \text{Sin}\pi & \text{Cos}\pi & 0 & 0 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

122. Ans: (d)

Sol: Water is one of the most efficient quenching media where maximum hardness is desired, but there is a small chance that it may cause distortion and tiny cracking.

123. Ans: (d)

Sol: Electron-beam machining (EBM) Characteristics:

- Cutting and hole making on thin materials;
- very small holes and slots;
- heat-affected zone;
- requires a vacuum;
- expensive equipment

124. Ans: (a)

Sol: In steam, air or pneumatic, hydraulic and vacuum systems, the acoustic monitoring enables to identify leaks, improper seal or gasket installation. Poorly seated valves can also be detected.

125. Ans: (a)

Sol: Jockeying can be described as the movement of a waiting customer from one queue to another (of shorter length or which appears to be moving faster, etc.) in anticipation of a shorter delay.

126. Ans: (c)

127. Ans: (a)

Sol: Euler's buckling load = $P = \dfrac{\pi^2 EI}{\ell_e^2}$

$$\text{Stress} = \frac{P}{A} = \frac{\pi^2 EI}{\ell_e^2 \times A}$$

$$r = \text{radius of gyration} = \sqrt{\frac{I}{A}}$$

$$\Rightarrow \sigma = \frac{\pi E r^2}{\ell_e^2}$$

$$\lambda = \text{slenderness ratio} = \frac{\ell_e}{r}$$

$$\Rightarrow \sigma = \frac{\pi E}{\lambda^2}$$

$$\Rightarrow \sigma \propto \frac{1}{\lambda^2}$$

When slenderness ratio is small, stress causing failure will be high according to

Euler's formula assuming ideal end conditions.

But this stress must not be greater than crushing stress. Also, in practice the end conditions will not be ideal leading to eccentricity in the loading. This results in bending moment which causes failure before the Euler's load. Hence for slenderness ratio < 120, Euler's theory is not used as it gives high value of failure stress since the crushing effect is not considered.

128. Ans: (b)

Sol: There are three main types of hardness measurements: *scratch*, *indentation*, and *rebound*. So given statement (I) is correct.

The Knoop hardness test is a micro hardness test – a test for mechanical hardness used particularly for very brittle materials or thin sheets, where only a small indentation may be made for testing purposes. So given statement (II) is also correct. But statement (II) is not correct explanation of statement (I). Hence option (b) is correct.

129. Ans: (a)

Sol: The critical temperature of air is approximately –141°C. The real gas in considered as an ideal gas when its temperature is approximately more than twice of critical temperature irrespective of its pressure.

130. Ans: (a)

131. Ans: (a)

132. Ans: (b)

133. Ans: (a)

134. Ans: (b)

135. Ans: (a)

136. Ans: (d)

137. Ans: (a)

Sol: Raw biogas from a digester cannot be used in all natural-gas-fuelled IC engines because it contains corrosive constituents that can significantly shorten the useful life of the engine.

ISRO

ONLINE TEST SERIES

No. of Tests : 15

Subject Wise Tests : 12 | Mock Tests : 3

Indian Space Research Organisation (ISRO)
Recruitment of Scientist/Engineer 'SC'

ELECTRONICS | MECHANICAL | COMPUTER SCIENCE

☑ Starts from **5th November 2019**

All tests will be available till 12-01-2020.

040 - 48539866 / 040 - 40136222 testseries@aceenggacademy.com

COAL INDIA LIMITED (CIL)

COAL INDIA

Management Trainees

Online Test Series

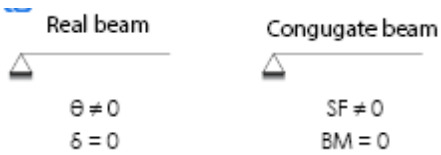
6 Full Length Mock Tests
Civil | Electrical | Mechanical

Starts From **10th Jan 2020**
All tests will be available till 28th February 2020

040 - 48539866 / 040 - 40136222 testseries@aceenggacademy.com

138. Ans: (a)

Sol:



Conjugate beam is an imaginary beam for which loading = $\frac{M}{EI}$ diagram of real beam and is based on

(a) Slope at a section in real beam = shear force at that section in conjugate beam

(b) Deflection at a section in real beam = Bending moment at that section in conjugate beam

$\therefore$ For a simple support of real beam $\theta \neq 0$, $\delta = 0$

$\therefore$ Corresponding support in conjugate beam should have $SF \neq 0$; $BM = 0$

And the support corresponding to this condition is simple support.

139. Ans: (b)

Sol:

- Proximity sensors are a form of position sensors and are used to determine when an object has moved to within some particular critical distance of the sensor.
- Proximity switches simply provide an on or off output to indicate whether or not the target is present in front of the probe.

140. Ans: (c)

Sol: The surfaces of the punch and of the die are both flat. Because the entire thickness is sheared at the same time, the punch force increases rapidly during shearing.

141. Ans: (d)

Sol: For 50% reaction axial flow compressor velocity triangles are congruent but blade angles are not same.

$\alpha_1 = \beta_2$ and $\beta_1 = \alpha_1$

but $\beta_1 \neq \beta_2$

142. Ans: (a)

143. Ans: (a)

144. Ans: (c)

145. Ans: (a)

Sol: Because there is no entropy generation in reversible process, there is no irreversibility. Hence, the exergy destruction is zero

146. Ans: (a)

Sol: When a ductile material is subjected to repeating (or) cycle loads, progressive and localized deformations occur leading to the

development of residual strains in the material. When the accumulated strain energy exceeds the toughness, the material fractures and this failure called as fatigue occurs at a load much less than the ultimate load of the structure. The failure load decreases with increase in the number of loadings.

147. Ans: (c)

Sol: In general, a measurement system consists of four types of elements:

(i) sensing,

(ii) signal conditioning,

(iii) signal processing and

(iv) data presentation elements.

A measurement system is often made a part of the control system. Hence Statement (II) is incorrect.

148. Ans: (a)

Sol: The lattice defects are created due to disturbance in order of lattice. This disturbance is generated due to either point defects, line defects or surface defects.

149. Ans: (b)

Sol: Honing is an operation that is used primarily to improve the surface finish of holes produced by processes such as *boring, drilling, and internal grinding*. The honing tool consists of a set of aluminum-oxide or silicon-carbide bonded abrasive sticks, usually called stones. *They are mounted on a mandrel* that rotates in the hole, at surface speeds of 45–90 m/min, applying a radial outward force on the hole surface. The stones can be adjusted radially for different hole sizes.

150. Ans: (a)

Sol: Adjacent springs having opposite hands, prevent the locking of coils, in the event of axial misalignment or buckling of springs.