Booklet No. 87120383

JEEDEC—2018

Subject : MECHANICAL ENGINEERING

Time : 2 hours | *Full Marks* : 100

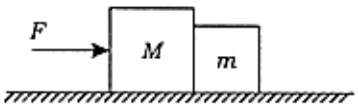
SEAL

Instructions

1. All questions are of objective type having four answer options for each. Only one option is correct. Correct answer will carry full marks 2. In case of incorrect answer or any combination of more than one answer, ½ mark will be deducted.
2. Questions must be answered on OMR sheet by darkening the appropriate bubble marked A, B, C or D.
3. Use only Black/Blue ball point pen to mark the answer by complete filling up of the respective bubbles.
4. Do not make any stray mark on the OMR.
5. Write question booklet number and your roll number carefully in the specified locations of the OMR. Also fill appropriate bubbles.
6. Write your name (in block letter), name of the examination centre and put your full signature in appropriate boxes in the OMR.
7. The OMRs will be processed by electronic means. Hence it is liable to become invalid if there is any mistake in the question booklet number or roll number entered or if there is any mistake in filling corresponding bubbles. Also it may become invalid if there is any discrepancy in the name of the candidate, name of the examination centre or signature of the candidate vis-a-vis what is given in the candidate's admit card. The OMR may also become invalid due to folding or putting stray marks on it or any damage to it. The consequence of such invalidation due to incorrect marking or careless handling by the candidate will be sole responsibility of candidate.
8. Candidates are not allowed to carry any written or printed material, calculator, docu-pen, log table, any communication device like mobile phones etc. inside the examination hall. Any candidate found with such items will be reported against and his/her candidature will be summarily cancelled.
9. Rough Work must be done on the question paper itself. Additional blank pages are given in the question paper for Rough Work.
10. Hand over the OMR to the invigilator before leaving the Examination Hall.

SEAL

SPACE FOR ROUGH WORK

1. 

Two blocks of masses M and m, being in contact with each other, rest on a frictionless horizontal floor as shown. When a horizontal force F is applied on M, the reaction force between the two blocks is

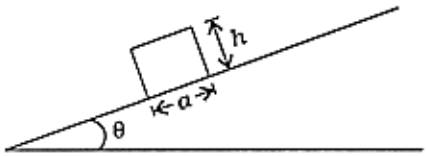
(A) $\frac{(M+m)F}{m}$ (B) $\frac{MF}{m}$ (C) $\frac{mF}{M}$ (D) $\frac{mF}{(M+m)}$

2. AB is the vertical diameter of a circle in a vertical plane. Another diameter CD makes an angle of 60° with AB. Both the diameters are assumed to be smooth. Ratio of time taken by a particle to slide along AB to the time taken by it to slide along CD (from rest in both the cases) is

(A) $1:\sqrt{3}$ (B) $\sqrt{2}:1$ (C) $1:\sqrt{2}$ (D) $\sqrt{3}:\sqrt{2}$

3. Two particles with masses in the ratio 1 : 4 are moving with equal kinetic energies in straight lines. The magnitude of their linear momentums will conform to the ratio

(A) 1 : 8 (B) 1 : 2 (C) $\sqrt{2}$: 1 (D) $\sqrt{2}:\sqrt{3}$

4. 

A uniform rectangular block with height h and width a rests on an inclined surface with a coefficient of static friction as μ, as shown. If the angle of inclination is slowly increased, what should be the relationship between a, h and μ for the block to tip over before sliding down the surface?

(A) $\mu = ah$ (B) $\mu < \frac{a}{h}$ (C) $a\mu < h$ (D) $\mu > \frac{a}{h}$

5. Two balls are projected from the same point making angles of 60° and 30° with the vertical axis. If both the balls are to attain the same height, then the ratio of the speeds of projection should be

(A) 1 : 2 (B) 1 : 1 (C) $\sqrt{3}$: 1 (D) $\sqrt{2}$: 1

6. A stone is whirled in a vertical circle by a string. The tension in the string is the greatest when stone is in the

(A) lowest position

(B) highest position

(C) position when the string is horizontal

(D) any position

7. A particle is traversing a curved path with a radius of curvature as 300 m. It travels with a linear speed of 108 km/hr and an acceleration of 4 m/s^2. The resultant acceleration of the particle at the moment is

(A) 1 m/s^2 (B) 5 m/s^2 (C) 6 m/s^2 (D) 8 m/s^2

8. A 13 m long uniform ladder is placed against a smooth vertical wall with its lower end 5 m from the wall. What should be the coefficient of friction between ladder and floor so that it remains in limiting equilibrium?

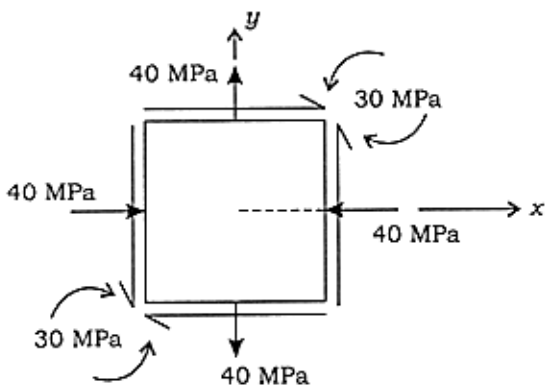
(A) 0·1083 (B) 0·1583 (C) 0·2083 (D) 0·2183

9. For the state of pure shear with shear stress τ, the strain energy stored per unit volume in a linearly elastic, homogenous and isotropic material having elastic constants E and ν (Young's modulus and Poisson's ratio respectively) will be

(A) $\frac{\tau^2}{E}(1+\nu)$ (B) $\frac{\tau^2}{2E}(1+\nu)$

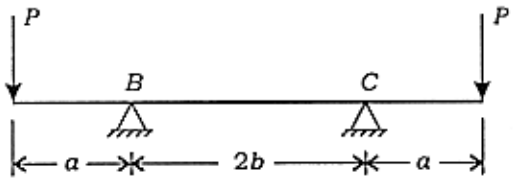
(C) $\frac{2\tau^2}{E}(1+\nu)$ (D) $\frac{\tau^2}{2E}(2+\nu)$

10.



The state of stress at a point in a loaded member is shown. The magnitude of the maximum shear stress at the point is

(A) 10 MPa (B) 30 MPa (C) 50 MPa (D) 100 MPa

11. 

For the prismatic beam shown, the elastic curve of the deflected beam between the supports B and C will be

(A) circular (B) parabolic (C) elliptic (D) straight line

12. The diameter of shaft A is twice the diameter of shaft B and both are made of same material. Assuming both the shafts to rotate at the same speed, the maximum power transmitted by shaft B is

(A) the same as that of shaft A (B) half of shaft A

(C) $\frac{1}{8}$th of shaft A (D) $\frac{1}{4}$th of shaft A

13. The Charpy test is conducted to measure

(A) toughness (B) creep strength

(C) fatigue strength (D) elastic strength of a material

14. A rectangular bar of length l, breadth b and thickness t is subjected to a longitudinal load of tensile nature. The resulting volumetric strain will be

(A) $\varepsilon(1-2\mu)$ (B) $2\varepsilon(1-\mu)$

(C) $\varepsilon(1+2\mu)$ (D) $3\varepsilon(1-2\mu)$

where ε and μ are longitudinal strain and Poisson's ratio respectively.

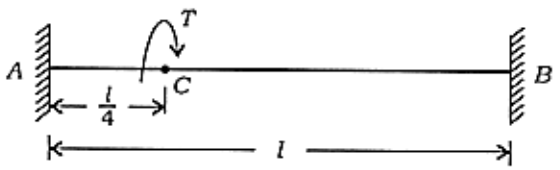
15. A thin prismatic ring of radius r is rotating in such a way that its peripheral speed is v. If ρ is the mass density of the material of the ring, then circumferential stress induced in the ring will be

(A) ρv^2 (B) $\frac{1}{3}\rho v^2$ (C) $\frac{1}{2}\rho v^2$ (D) $\sqrt{2}\rho v^2$

16. A cantilever beam 1·5 m long carries a uniformly distributed load over the entire length. The slope at the free end is found to be 1·5°. The deflection at the free end will be

(A) 26·45 mm (B) 29·45 mm (C) 31·45 mm (D) 32·45 mm

17.



A round solid shaft of diameter d and length l, fixed at both ends A and B, is subjected to a twisting moment T at C, at a distance $\frac{l}{4}$ from fixed end A as shown. The maximum torsional shear stresses in the parts AC and CB will be

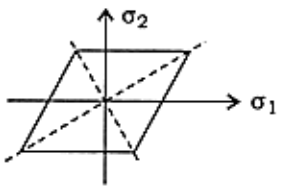
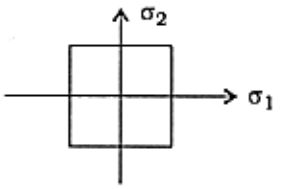
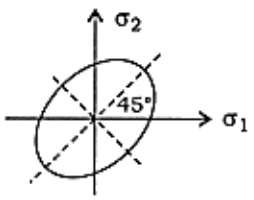
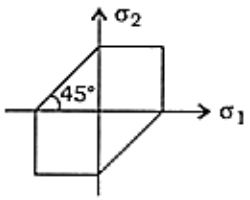
(A) equal

(B) in the ratio 1 : 3

(C) in the ratio 3 : 1

(D) indeterminate

18. Match List—I (failure theories) with List—II (figure of failure envelopes) and select the correct answer using the codes given below :

List—I		*List—II*
a. Maximum principal stress theory	1.	
b. Maximum shear stress theory	2.	
c. Octahedral shear stress theory	3.	
d. Maximum principal strain theory	4.	

(A) a–2, b–1, c–3, d–4

(B) a–2, b–4, c–3, d–1

(C) a–4, b–2, c–3, d–1

(D) a–2, b–4, c–1, d–3

19. Which of the following statements regarding 'mitre' gears is correct?

These are employed for

(A) minimum backlash (B) great speed reduction

(C) equal speed (D) minimum axial thrust

20. Mid-point of the floating link of an elliptic trammel traces a/an

(A) straight line (B) circle (C) parabola (D) ellipse

21. Inversion of a mechanism is

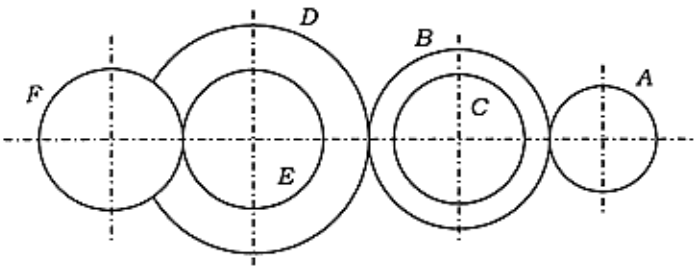
(A) changing of higher pair to lower pair

(B) obtained by fixing different links in a kinematic chain

(C) turning it upside down

(D) obtained by reversing the input and output motion

22.



Consider the gear train shown. Gears *B*, *C* and *D*, *E* are moulded on the same shafts. If *A* rotates at 969 r.p.m., then the speed of *F* will be

Gear	*A*	*B*	*C*	*D*	*E*	*F*
Nos. of teeth	20	50	25	76	26	65

(A) 98 r.p.m. (B) 100 r.p.m. (C) 102 r.p.m. (D) 104 r.p.m.

23. For an involute straight tooth spur gear, the ratio of the pitch circle radius to the base circle radius is

(A) $\sin\phi$ (B) $\cos\phi$ (C) $\sec\phi$ (D) $\operatorname{cosec}\phi$

where ϕ is the pressure angle of the gears.

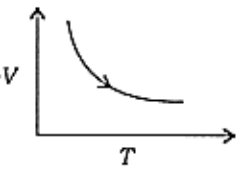
24. The equation of free vibrations of a system is $\ddot{x} + 36\pi^2 x = 0$. Its natural frequency is

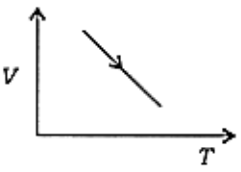
(A) 3 Hz (B) 6 Hz (C) 3π Hz (D) 6π Hz

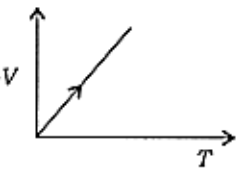
25. A refrigerator with its door open is left running in a closed room. If the fan is also kept on and heat transfer from the room is negligible, then room temperature will

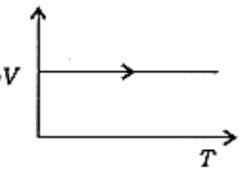
(A) fall for sometime and then rise
(B) keep on increasing
(C) decrease continuously
(D) remain unaffected

26. Which one of the following pV-T diagrams correctly represents an ideal gas?

(A) 

(B) 

(C) 

(D) 

27. In a reversible isothermal process undergone by an ideal gas

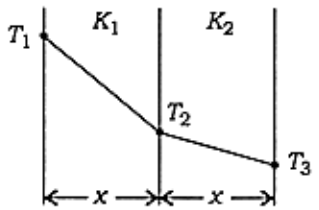
(A) heat transfer is zero
(B) change in enthalpy is zero
(C) work transfer is zero
(D) heat transfer is equal to work transfer

28. For a given set of operating pressure limits of a Rankine cycle, the highest efficiency occurs for

(A) saturated cycle
(B) superheated cycle
(C) reheat cycle
(D) regenerative cycle

29. For a single-stage impulse turbine with a rotor of 2 m diameter and a speed of 3000 r.p.m., the optimum absolute inlet velocity of steam in m/s is

(A) 334 (B) 356 (C) 668 (D) 711

30. 

The temperature drop through each layer of a two-layer furnace wall is shown. Thermal conductivities of the layers are K_1 and K_2 respectively. Assume that the external temperatures are T_1 and T_3 which are maintained constant $T_1 > T_3$. If thickness of both the layers are same, then

(A) $K_1 > K_2$

(B) $K_1 < K_2$

(C) $K_1 = K_2$, but heat flow through material 1 is larger than that through material 2.

(D) $K_1 = K_2$, but heat flow through material 1 is less than that through material 2.

31. The ratio of energy transferred by convection to that by conduction is called

(A) Stanton number (B) Nusselt number

(C) Biot number (D) Peclet number

32. The boundary layer is defined as a

(A) thin layer at the surface, where gradients of both velocity and temperature are small.

(B) thin layer at the surface, where velocity and velocity gradients are large.

(C) thick layer at the surface, where velocity and temperature gradients are large.

(D) thin layer at the surface, where gradients of both velocity and temperature are large.

33. The basic law of heat conduction is

(A) Fourier's law (B) Newton's law

(C) Stefan's law (D) first law of thermodynamics

34. The thermal conductivity in SI unit is expressed as

(A) $\frac{J}{m^2K}$ (B) $\frac{W}{mK}$ (C) $\frac{W}{mK\ sec}$ (D) $\frac{W}{m^2}$

where J = Joule, W = Watt, m = metre and K = Kelvin.

35. Power available at the shaft of an IC engine is called

(A) brake power (B) indicated power

(C) net indicated power (D) pumping power

36. The process of supplying the intake air to the engine cylinder at a density more than density of the surrounding atmosphere is called

(A) scavanging (B) supercharging (C) detonation (D) isochronism

37. Optimum pressure ratio for maximum specific work output for ideal gas turbine plant operating at initial temperature of 300 K and maximum temperature of 1000 K is close to

(A) 4 (B) 8 (C) 12 (D) 16

38. A manufacturer produces two types of products 1 and 2, number of units produced being x_1 and x_2 respectively. If profits for each unit of 1 and 2 are Rs 2/- and Rs 5/- respectively, then the maximum profit possible is

(A) Rs 29/- (B) Rs 38/- (C) Rs 44/- (D) Rs 50/-

The production constraints are

$$3x_1 + x_2 \leq 24$$
$$x_1 + x_2 \leq 10$$
$$x_1, x_2 \geq 0$$

39. Two machines of same capacity/production rate are available for use. On machine #1, fixed cost is Rs 100/- and variable cost is Rs 2/- per piece produced. Corresponding numbers for machine #2 are Rs 200/- and Re 1/- respectively. For some strategic reasons, both the machines are to be run concurrently. Sale price for first 800 units produced is Rs 3·50/- per unit and subsequently it is Rs 3·00/- per unit. The break even production rate for each machine is

(A) 75/- (B) 100/- (C) 150/- (D) 600/-

40. Optimisation is a process of

(A) minimization of an undesirable quantity, while satisfying some constraints

(B) maximization of a desirable quantity, while satisfying some constraints

(C) Both (A) and (B) above

(D) analysis of an engineering system

41. Continuous chip is formed when cutting speed is

(A) low (B) medium (C) high (D) of any value

42. A single point cutting tool having tool signatures as 10, 10, 6, 6, 8, 8, 2 in ASA will have back rake angle as

(A) 2 (B) 6 (C) 8 (D) 10

43. Jigs and fixtures are used

(A) to increase productivity and allow rest time to operator

(B) to facilitate inter changeability, increasing productivity and accuracy

(C) to reduce cost of manufacture

(D) to remove the chips

44. No cutting fluid is normally used while machining

(A) alloy steels (B) cast iron

(C) low-carbon steel (D) aluminum

45. Tumbler gears are used in a lathe

(A) to cut gears

(B) to reduce the spindle speed

(C) to transmit power from the lead screw to the carriage

(D) to reverse the direction of rotation of driven gears

46. Feed movement of the job, in case of shaping machine, is done at the

(A) end of return stroke (B) beginning of the cutting stroke

(C) middle of the cutting stroke (D) end of the cutting stroke

47. It is required to cut screw threads of 2 mm pitch on a lathe. The lead screw has a pitch of 6 mm. If the spindle speed is 60 r.p.m., then the speed of the lead screw will be

(A) 10 r.p.m. (B) 20 r.p.m. (C) 120 r.p.m. (D) 180 r.p.m.

48. The number of teeth on a translating gear for a lathe is

(A) 117 (B) 127 (C) 137 (D) 147

49. A standard dividing head is equipped with the following index plates :

Plate–1 with 15, 16, 17, 18, 19, 20 hole circles

Plate–2 with 21, 23, 27, 29, 31, 33 hole circles

Plate–3 with 37, 39, 41, 43, 47, 49 hole circles

For obtaining 24 divisions on a workpiece by simple indexing

(A) only hole plate 2 alone can be used

(B) hole plates 1 and 2 are to be used together

(C) hole plates 1 and 3 are to be used together

(D) any of the three hole plates alone can be used

50. In orthogonal cutting, the depth of cut is 0·5 mm at a cutting velocity 120 m/min. If the chip thickness is 0·75 mm, then the chip velocity over the tool face is

(A) 1·33 m/s (B) 2 m/s (C) 2·5 m/s (D) 3 m/s

Rake angle of the tool may be taken as 30°.