

DO NOT OPEN THIS TEST BOOKLET TILL YOU ARE ASKED TO DO SO.

TR/TES/MECH-I/M/DEGREE/V(A)/24

Test Booklet Series

**TEST BOOKLET
MECHANICAL ENGINEERING
PAPER – I**



(Signature of the Candidate)

(Invigilator's Signature)

Time Allowed – 3 hours (Three hours)

Maximum Marks – 200

INSTRUCTIONS

1. IMMEDIATELY BEFORE THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET DOES NOT HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY TEST BOOKLET OF SAME SERIES.
2. ENCODE CLEARLY THE TEST BOOKLET SERIES IN THE OMR ANSWER SHEET ONLY IN THE APPROPRIATE PLACE IN THE ANSWER SHEET BY BLACK BALL POINT PEN ONLY.
3. This Test Booklet is divided into three SECTIONS i.e., SECTION-A, SECTION-B and SECTION-C.
(A) SECTION-A (MCQ pattern) contains 40 items (questions). Each question, carrying 2 (two) marks only, has four responses (answers). You will select the response which you want to mark on the OMR Sheet. In case you feel that there is more than one correct response, mark the response which you consider the most appropriate. In any case choose ONLY ONE response for each item.
(B) Questions under SECTION-B (Conventional Method) and SECTION-C (Conventional Method) are to be answered in separate Answer Book.
4. You have to mark all your responses of SECTION-A by Black Ball Point pen only on the separate OMR Answer Sheet provided. See directions in the Answer Sheet.
5. Before you proceed to mark in the Answer Sheet the responses to various items of SECTION-A in the Text Booklet, you have to fill in some particulars in the Answer Sheet.
6. On completion of the Examination, you should handover the OMR Answer Sheet for SECTION-A and Answer Book for SECTION-B and C to the invigilator only. You are permitted to take the Test Booklet with you.
7. Sheets for rough work are appended on the Test Booklet at the end.
8. Instructions for wrong and multiple answer(s) Section-A :
(a) There will be four alternatives for the answer to every question. However, there will be no negative marking for wrong answer.
(b) If a candidate gives more than one answer, it will be treated as a Wrong Answer even if one of the given answers happens to be correct.

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INSTRUCTIONS

1. There are a total of 60 questions. Q. Nos. 1 to 40 in SECTION-A are Multiple choice questions having 2 marks each.
2. In SECTION-B there are 15 questions. Q. Nos. 41 to 55 of 6 marks each, answers to which is restricted to 40 words each.
3. In SECTION-C there are 5 numerical questions. Q. Nos. 56 to 60 of 6 marks each.
4. All symbols used in the questions carry their usual meanings.

SECTION -A

Example : Poise is the unit of

- | | |
|--------------------------------|-------------------------|
| (A) Surface tension | (B) Buoyant force |
| ● (C) Coefficient of viscosity | (D) Gravitational force |

Answer : ● Coefficient of viscosity

- Choose the correct answer from the following :

$$2 \times 40 = 80$$

1. The necessary and sufficient condition for bodies in flotation to be in stable equilibrium is that the centre of gravity is located below the

(A) meta centre	(B) centre of buoyancy
(C) epicentre	(D) centroid
2. The bending moment at a section tends to bend or deflect the beam and the internal stresses resist bending. The resistance offered by the internal stresses to the bending is called

(A) compressive stress	(B) shear stress
(C) bending stress	(D) elastic stress

3. The temperature stress is a function of

- (i) coefficient of linear expansion (ii) temperature rise
(iii) modulus of elasticity

The correct answer is

- (A) (i) and (ii) only (B) (i) and (iii) only
(C) (ii) and (iii) only (D) (i), (ii), and (iii) only

4. At a principal plane

- (A) no stress exists
(B) only uniaxial stress acts
(C) the normal stress is maximum or minimum and shear stress are zero
(D) the tensile stress is zero and the shear stress is maximum

5. The strain energy stored in a body of volume V due to direct uniform stress σ is

- (A) $\frac{\sigma E}{V}$ (B) $\frac{\sigma^2 V}{E}$
(C) $\frac{\sigma^2 V}{2E}$ (D) $\frac{\sigma V^2}{E}$

6. A thin cylindrical shell of diameter 'd' and wall thickness 't' is subjected to an internal fluid pressure p. If E is the Young's modulus and μ is the Poisson's ratio for the cylinder material, then circumferential (diametral) strain will be

- (A) $\frac{pd}{4tE}(2-\mu)$ (B) $\frac{pd}{4tE}(1-2\mu)$
(C) $\frac{pd}{4tE}(5-4\mu)$ (D) $\frac{pd}{4tE}(4-5\mu)$

7. The maximum bending moment in a simply supported beam carrying two unequal concentrated loads occurs
- (A) at the mid span (B) under any of the loads
(C) under the heavier load (D) not necessarily under any load
8. When a rectangular section beam is loaded transversely along the length, shear stress develops on its
- (A) top fibre (B) middle fibre
(C) bottom fibre (D) every horizontal plane
9. A cantilever beam of rectangular cross-section is subjected to a load W at its free end. If the depth of the beam is doubled and the load is halved, the deflection of the free end as compared to original deflection will be
- (A) half (B) double
(C) one-eighth (D) one-sixteenth
10. The shear stress at a point in a shaft subjected to a torque is
- (A) directly proportional to polar moment of inertia and to the distance of the point from the axis
(B) directly proportional to the applied torque and inversely proportional to the polar moment of inertia
(C) direct proportional to the applied torque and polar moment of inertia
(D) inversely proportional to the applied torque and the polar moment of inertia
11. For a maximum bending moment shear force at the section should be
- (A) zero (B) maximum
(C) minimum (D) None of these

12. A static fluid can have
- (A) non-zero normal and shear stress
 - (B) negative normal stress and zero-shear stress
 - (C) positive normal stress and zero shear stress
 - (D) zero normal stress and non-zero shear stress
13. Oil spreads on the surface of water because
- (A) oil is less dense than water
 - (B) oil is immiscible water
 - (C) oil has less surface tension than water
 - (D) oil has low vapour pressure
14. Maximum bending moment in a cantilever carrying a concentrated load at the free end occurs
- (A) at the fixed end
 - (B) at the free end
 - (C) at the mid span
 - (D) None of these
15. The distance from the centre of buoyancy to the meta centre is given by I/V , where V is the volume of fluid displaced. What does I represent ?
- (A) moment of inertia of horizontal section of the body taken at the surface of the fluid
 - (B) moment of inertia about its vertical centroidal axis
 - (C) polar moment of inertia
 - (D) moment of inertia about its horizontal centroidal axis
16. A streamline is a line
- (A) which is along the path of particle
 - (B) which is always parallel to the direction of flow
 - (C) along which there is no flow
 - (D) on which tangent drawn at any point gives the direction of velocity at that point

17. Which one of the following statements is true for a two-dimensional flow of ideal fluids ?
- (A) Potential function exists if stream function exists
 - (B) Stream function may or may not exist
 - (C) Both potential function and stream function must exist
 - (D) Stream function will exist but potential function may or may not exist
18. The ratio of average shear stress to the maximum shear stress in a beam with a square cross-section is
- (A) 1
 - (B) $\frac{2}{3}$
 - (C) $\frac{3}{2}$
 - (D) 2
19. The pressure drop in a pipe flow is directly proportional to the mean velocity. It is suggested that the
- (A) flow is laminar
 - (B) flow is turbulent
 - (C) pipe is smooth
 - (D) pipe is rough
20. At the point of boundary layer separation
- (A) shear stress is maximum
 - (B) shear stress is zero
 - (C) velocity is negative
 - (D) density variation is maximum
21. How is the best hydraulic channel cross-section defined ?
- (A) the section with minimum roughness coefficient
 - (B) the section that has a maximum area for a given flow
 - (C) the section that has a minimum wetted perimeter
 - (D) the section that has a maximum wetted area

22. What is the safe static tensile load in kN for M36×4C bolt of mild steel having a yield stress of 280MPa and a factor of safety 1.5 ?
- (A) 285 (B) 190
(C) 142.5 (D) 95
23. The cross-head, connecting rod and eccentric etc. in steam engine are provided with a bolt of the _____ type.
- (A) Cylindrical headed bolt (B) T-headed bolt
(C) Square headed bolt (D) Countersunk headed bolt
24. Which theory of failure will you use for aluminium components under steady loading ?
- (A) Principal stress theory (B) Maximum shear stress theory
(C) Strain energy theory (D) Principal strain theory
25. Which of the following theories of failure is not suitable for ductile material ?
- (A) Maximum shear stress theory (B) Maximum principal strain theory
(C) Maximum total strain energy theory (D) Maximum principal stress theory
26. Stoke is the unit of
- (A) kinematic viscosity in C. G. S. units
(B) kinematic viscosity in M. K. S. units
(C) dynamic viscosity in M. K. S. units
(D) dynamic viscosity in S. I. units
27. A flow whose streamline is represented by a curve, is called
- (A) one-dimensional flow (B) two-dimensional flow
(C) three-dimensional flow (D) four-dimensional flow

28. The discharge over a rectangular notch is
- (A) inversely proportional to $H^{3/2}$ (B) directly proportional to $H^{3/2}$
 (C) inversely proportional to $H^{5/2}$ (D) directly proportional to $H^{5/2}$
29. A jet of water discharging from a 40 mm diameter orifice has a diameter of 32 mm at its vena contracta. The coefficient of contraction is
- (A) 0.64 (B) 0.46
 (C) 0.78 (D) 0.87
30. Water is a _____ fluid.
- (A) real (B) ideal
 (C) newtonian (D) non-newtonian
31. A single-acting two-stage compressor with complete intercooling delivers air at 16 bar. Assuming an intake state of 1 bar at 15°C, the pressure ratio per stage is
- (A) 16 (B) 8
 (C) 4 (D) 2
32. Compressors used in gas turbines are of
- (A) reciprocating type (B) centrifugal type
 (C) axial-flow type (D) None of these
- 33 Consider the following system :
1. An electric heater 2. A gas turbine 3. A reciprocating compressor.
- The steady flow energy equation can be applied to which of the above systems ?
- (A) 1 and 2 only (B) 1 and 3 only
 (C) 1, 2 and 3 (D) 2 and 3 only

34. For a gas turbine power plant, identify the correct pair of statements.
- P. Smaller in size compared to steam power plant for same power output
 - Q. Starts quickly compared to steam power plant
 - R. Works on the principle of Rankine cycle
 - S. Good compatibility with solid fuel
- (A) P, S, R (B) R, S
(C) Q, R (D) P, Q
35. Supersaturated flow occurs in a steam nozzle due to delay in
- (A) Throttling (B) Condensation
(C) Evaporation (D) Entropy drop
36. A structural member subjected to an axial compressive force is called
- (A) Beam (B) Column
(C) Frame (D) Strut
37. Which of the following refrigeration systems is not suitable for solar cooling ?
- (A) Ejector refrigeration system
(B) Vapour absorption system
(C) Desiccant refrigeration system
(D) Vortex tube refrigeration system
38. The ball bearings are provided with a cage
- (A) to reduce friction
(B) to facilitate slipping of balls
(C) to prevent the lubricant from flowing out
(D) to maintain the balls at a fixed distance apart

39. The resistance to fatigue of a material is measured by

(A) Elastic limit

(B) Young's modulus

(C) Ultimate tensile strength

(D) Endurance limit

40. The gear train usually employed in clocks is a

(A) simple gear train

(B) reverted gear train

(C) sun and planet gear

(D) differential gear.

SECTION – B

● Answer *all* the following questions :

6×15=90

41. State the shear stress equation and write the meaning of symbols used and draw the shear and bending stress distribution diagram for solid rectangular section.
42. Draw stress-strain diagram for ductile material in tension.
43. Differentiate between sudden loading and impact loading. Also state the example of each type of loading.
44. State and prove Bernoulli's theorem for flow of fluids. State limitation of Bernoulli's theorem.
45. Explain the construction and working of venturimeter.
46. Differentiate between Francis and Kaplan turbine.
47. State the inversions of four bar chain mechanism and explain any one with neat sketch.
48. Compare open-belt and cross-belt drive on the basis of (i) Velocity Ratio, (ii) Application, (iii) Direction of Driven Pulley (iv) Length of Belt.
49. Explain with neat sketch the working of epicyclic gear train giving its applications.
50. Explain Newton's law of viscosity and compare it with Hooke's law.
51. Explain capillary action, what are the different forces involved in capillary action ?
52. What is the significance of Dimensionless Number, explain Euler's Number.
53. What is meant by priming of a centrifugal pump, when we require it ?
54. What is the function of draft tube, why does a pelton wheel not possess any draft tube ?
55. State the law of gearing.

SECTION - C

6×5=30

● Answer all the following questions :

56. A solid circular shaft of diameter 100 mm is subjected to an axial stress of 50 MPa. It is further subjected to a torque of 10 kNm. The maximum principal stress experienced on the shaft will be how much ?

57. A steady incompressible flow given by

$$u = 2x^2 + y^2 \text{ and } v = -4xy.$$

What is the convective acceleration along x-direction at point (1, 2) ? Calculate.

58. A jet of water impinges with velocity v on a plate which is inclined at an angle α with the direction of jet. Calculate the force exerted on the plate in a direction normal to flow.

59. The load on the journal bearing is 150 kN due to turbine shaft of 300 mm diameter running at 1800 r.p.m. Determine the following :

- (i) Length of the bearing if the allowable bearing pressure is 1.6 N/mm², and
- (ii) Amount of heat to be removed by the lubricant per minute if the bearing temperature is 60°C and viscosity of the oil at 60°C is 0.02 kg/m-s and the bearing clearance is 0.25 mm.

60. A horizontal venturimeter with inlet diameter 30 cm and throat diameter 10 cm is used to measure the flow of water. The pressure intensity at the inlet is 13.734 N/cm², while the vacuum pressure head at the throat is 37 cm of mercury. Find the rate of flow. Find also the value of C_d for the venturimeter. Assume that 4% of the differential head is lost between the inlet and throat.