

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

TR/TES/M-I/DEG/16

Test Booklet Series

TEST BOOKLET
MECHANICAL ENGINEERING PAPER – I
(DEGREE)



(Signature of the Candidate)

(Invigilator's Signature)

Time Allowed – 3 hours (Three hours)

Maximum Marks – 200

I N S T R U C T I O N S

1. IMMEDIATELY AFTER 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 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 & 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. There shall be no negative marking for wrong / multiple answer.
 - (B) Questions under Section -B (Conventional Method) & 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 answer the responses to various items in the Test Booklet, you have to fill in some particulars both in the Answer sheet for Section-A and in the Answer Book for Section-B and Section-C
6. On completion of the Examination, you should hand over the OMR Answer Sheet for Section – A & Answer Book for Section – B & 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.

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All symbols have their usual meanings.

SECTION – A

Answer *all* questions. Each question carries 2 marks.

40×2=80

Choose the correct answer from the four alternatives provided with each question and mark on the OMR Sheet.

Example : Poise is the unit of

(A) Surface tension

(B) Buoyant force

● (C) Coefficient of viscosity

(D) Gravitational force

1. The buckling load in a steel column is
 - (A) related to the length
 - (B) directly proportional to the slenderness ratio
 - (C) inversely proportional to the slenderness ratio
 - (D) non-linearly related to the slenderness ratio
2. A Mohr's circle reduces to a point when the body is subjected to
 - (A) pure shear
 - (B) uniaxial stress only
 - (C) equal and opposite axial stresses on two mutually perpendicular planes, the planes being free of shear
 - (D) equal axial stresses on two mutually perpendicular planes, the planes being free of shear.
3. The plane of maximum shear stress has normal stress that is
 - (A) maximum
 - (B) minimum
 - (C) zero
 - (D) none of these
4. When bending moment M and torque T are applied on a shaft, then equivalent torque is
 - (A) $M + T$
 - (B) $\sqrt{M^2 + T^2}$
 - (C) $\frac{1}{2}\sqrt{M^2 + T^2}$
 - (D) $\frac{1}{2} \left(M + \sqrt{M^2 + T^2} \right)$
5. For a circular column having its ends hinged, the slenderness ratio is 160. The L/D ratio of the column is
 - (A) 80
 - (B) 57
 - (C) 40
 - (D) 20

6. A simply supported beam of span L and flexural rigidity $E I$, carries a unit point load at its centre. The strain energy in the beam due to bending is
- (A) $\frac{L^3}{48 EI}$
- (B) $\frac{L^3}{192 EI}$
- (C) $\frac{L^3}{96 EI}$
- (D) $\frac{L^3}{16 EI}$
7. If a circular shaft is subjected to a torque T and a bending moment M , the ratio of the maximum shear stress to the maximum bending stress is
- (A) $\frac{2M}{T}$
- (B) $\frac{T}{2M}$
- (C) $\frac{2T}{M}$
- (D) $\frac{M}{2T}$
8. Design of shafts made of brittle materials is based on
- (A) Guest's theory
- (B) Rankine's theory
- (C) St. Venant's theory
- (D) Von Mises theory
9. In red wood viscometer
- (A) absolute value of coefficient of viscosity is determined
- (B) part of the head of fluid is utilised in overcoming friction
- (C) fluid discharge through orifice with negligible velocity
- (D) comparison of viscosity is done
10. A balloon lifting in air follows the
- (A) law of gravitation
- (B) Archimedes principle
- (C) principle of buoyancy
- (D) All of the above
11. Centre of pressure on an inclined plane is
- (A) at the centroid
- (B) above the centroid
- (C) below the centroid
- (D) at meta - centre
12. When a body floating in a liquid is displaced slightly, it oscillates about
- (A) c. g of the body
- (B) centre of pressure
- (C) centre of buoyancy
- (D) meta - centre

13. A control volume refers to
 (A) a closed system
 (B) a specified mass
 (C) an isolated system
 (D) a fixed region in space
14. In equilibrium condition, fluids are not able to sustain
 (A) shear force
 (B) resistance to viscosity
 (C) surface tension
 (D) geometric similitude
15. A large Reynold number is indication of
 (A) smooth and streamline flow
 (B) laminar flow
 (C) steady flow
 (D) highly turbulent flow
16. A rotameter is a device used to measure
 (A) velocity of fluid in pipes
 (B) velocity of gauges
 (C) vortex flow
 (D) quantity of fluids
17. In full depth $14\frac{1}{2}^\circ$ involute system, the smallest number of teeth in a pinion which meshes with rack without interference is
 (A) 12
 (B) 16
 (C) 25
 (D) 32
18. In a multiple V belt drive, when a single belt is damaged, it is preferable to change the complete set to
 (A) reduce vibration
 (B) reduce slip
 (C) ensure uniform loading
 (D) ensure proper alignment
19. The centre of gravity of the coupler link in a 4-bar mechanism would experience
 (A) no acceleration
 (B) only linear acceleration
 (C) only angular acceleration
 (D) both linear and angular acceleration
20. The tooth profile most commonly used in gear drives for power transmission is
 (A) a cycloid
 (B) an involute
 (C) an ellipse
 (D) a parabola
21. The equation $m \frac{d^2x}{dt^2} + C \frac{dx}{dt} + Kx = 0$, represents
 (A) free vibration
 (B) forced vibration
 (C) periodically forced vibration
 (D) free vibration with viscous damping

22. Critical damping is a function of
- (A) mass and stiffness
 - (B) mass and damping coefficient
 - (C) stiffness and natural frequency
 - (D) natural frequency and damping coefficient
23. Ratio of amplitude of the two successive oscillations in an underdamped system is
- (A) constant
 - (B) linear
 - (C) logarithmic
 - (D) exponential
24. Rotating shafts tend to vibrate violently at whirling speeds because
- (A) the shafts are rotating at varying speeds
 - (B) bearing centre line coincide with the shaft axis
 - (C) the system is unbalanced
 - (D) resonance is caused due to the heavy weight of the rotor
25. The fatigue life of a part can be improved by
- (A) electroplating
 - (B) polishing
 - (C) coating
 - (D) shot peening
26. Stress concentration in static loading is more serious in
- (A) ductile materials
 - (B) brittle materials
 - (C) equally serious in both cases
 - (D) depends on other factors
27. In the assembly of pulley, key and shaft
- (A) pulley is made the weakest
 - (B) key is made the weakest
 - (C) key is made the strongest
 - (D) all the three are designed for equal strength
28. The shock absorbing capacity of a bolt can be increased by
- (A) tightening it properly
 - (B) increasing shank diameter
 - (C) grinding the shank
 - (D) using washer
29. B. S. W. threads have the angle equal to
- (A) 55°
 - (B) 60°
 - (C) 20°
 - (D) 58°
30. The most suitable bearing for carrying very heavy loads with slow speed is
- (A) hydrodynamic bearing
 - (B) ball bearing
 - (C) roller bearing
 - (D) hydrostatic bearing

31. In an oil-lubricated journal bearing, coefficient of friction between the journal and the bearing
- (A) remains constant at all speeds
 - (B) is minimum at zero speed and increases monotonically with increase in speed
 - (C) is maximum at zero speed and decreases monotonically with increase in speed
 - (D) becomes minimum at an optimum speed and then increases with further increase in speed
32. In designing a plate clutch, assumption of uniform wear conditions is made because
- (A) it is closer to real life situation
 - (B) it leads to a safer design
 - (C) it leads to cost effective design
 - (D) no other assumption is possible
33. Number of processes in a Rankine cycle are
- (A) 3
 - (B) 4
 - (C) 5
 - (D) 6
34. A gas turbine cycle with heat exchanger and reheating improves
- (A) only the thermal efficiency
 - (B) only the specific power output
 - (C) both thermal efficiency and specific power output
 - (D) neither thermal efficiency nor specific power output
35. The critical pressure ratio for maximum discharge through nozzle can be given as
- (A) $\left(\frac{1}{n+1}\right)^{\frac{n}{n-1}}$
 - (B) $\left(\frac{n+1}{2}\right)^{\frac{n}{n-1}}$
 - (C) $\left(\frac{2}{n+1}\right)^{\frac{n-1}{n}}$
 - (D) $\left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$
36. When the back pressure of nozzle is below the designed value of pressure at exit of nozzle, then the nozzle is called
- (A) under-expanding nozzle
 - (B) over-expanding nozzle
 - (C) designed operation nozzle
 - (D) None of these

37. In case of an impulse turbine, the blade velocity coefficient shall have its value for actual case as

- (A) < 1
- (B) > 1
- (C) $= 1$
- (D) None of these

38. The ratio of work done to the energy supplied to rotor in a turbine stage is called

- (A) blade efficiency
- (B) stage efficiency
- (C) nozzle efficiency
- (D) none of these

39. Steam turbines having the complete nozzle coverage of blades are called

- (A) full admission turbine
- (B) partial admission turbine
- (C) reaction turbine
- (D) none of these

40. Which of the following may be reaction turbine ?

- (A) Curtis turbine
- (B) Rateau turbine
- (C) Parson's turbine
- (D) None of these

SECTION - B

Answer all questions.

Each question carries six marks.

15×6=90

1. State Newton's law of viscosity and give examples of its application.
2. What do you understand by the term 'Temperature Lapse-Rate' ?
3. What is the difference between sluice gate and lock gates ?
4. Explain the terms 'meta-centre' and 'meta-centric height'.
5. Differentiate between forced vortex and free vortex flow.
6. Name the different forces present in a fluid flow. For the Euler's equation of motion, which forces are taken into consideration ?
7. How will you find the stresses and load carried by each member of a composite bar ?
8. What is bulk modulus ? What is the expression for Young's modulus in terms of bulk modulus and Poisson's ratio ?

9. Define the term 'obliquity' and how it is determined ?
10. Explain the terms : proof stress and proof resilience.
11. Differentiate between a cantilever and a simply supported beam.
12. Define 'boiler'. Enlist the requirements of a good boiler.
13. Define equivalent evaporation and also give its significance.
14. Define slip, percentage slip and negative slip of a reciprocating pump.
15. What should be the value of margin so that there is no failure due to tearing of the plate between the rivet hold and the edge of the plate ?

SECTION - C

Answer *all* questions.

Each question carries six marks.

$5 \times 6 = 30$

1. A single riveted double cover butt joint in a structure is used for connecting two plates 12 mm thick. The diameter of the rivets is 24 mm. The permissible stresses are 120 N/mm² in tension, 100 N/mm² in shear and 200 N/mm² in bearing. Calculate the necessary pitch and efficiency of the joint.
2. An axial pull of 35000 N is acting on a bar consisting of three lengths as shown in Figure 1. If the Young's modulus = 2.1×10^5 N/mm², determine
 - (i) stresses in each section and
 - (ii) total extension of the bar.

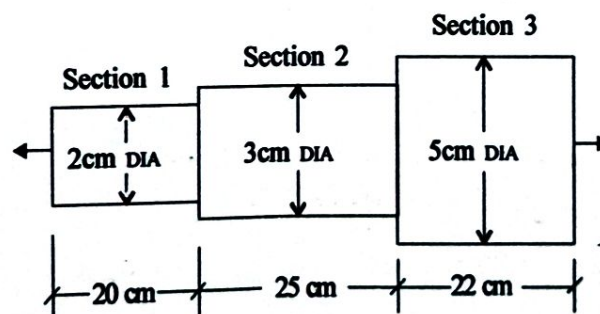


Fig 1

3. Determine the height of chimney required in a boiler having natural draught equivalent to 20 mm of water. The flue gases are at temperature of 300°C , atmospheric air temperature is 27°C and 18 kg air per kg of fuel is required in boiler.
4. A single acting reciprocating pump, running at 50 rpm, delivers $0.01 \text{ m}^3/\text{sec}$ of water. The diameter of the piston is 20 cm and stroke length 40 cm. Determine the theoretical discharge and coefficient of discharge of the pump.
5. Water is flowing through a pipe of 5 cm diameter under a pressure of 29.43 N/cm^2 (gauge) and with mean velocity of 2 m/s. Find the total head or total energy per unit weight of the water at a cross-section, which is 5 m above the datum line.