043/2025

PART – II

Total Number of Questions : 40	Maximum Marks : 200	Time : 3 Hours

INSTRUCTIONS (നിർദ്ദേശങ്ങൾ)

1. Question cum Answer Booklets are processed by electronic means. The following instructions are to be strictly followed to avoid invalidation of answer scripts.
(ചോദ്യവും ഉത്തരവും അടങ്ങുന്ന ഈ ബുക്ക് ലെറ്റുകൾ ഇലക്ട്രോണിക് സാങ്കേതിക വിദ്യയുടെ സഹായത്തോടുകൂടെ മൂല്യനിർണ്ണയം നടത്തുന്നതിനാൽ ഇവ അസാധുവാകാതിരിക്കുവാൻ താഴെപ്പറയുന്ന നിർദ്ദേശങ്ങൾ പൂർണ്ണമായും പാലിക്കുക.)

2. The first page of this question cum Answer Booklet is an OMR data Sheet (Part I). All entries in the OMR sheet are to be made with blue or black ball point pen only.
(ഈ പുസ്തകത്തിന്റെ ഒന്നാമത്തെ പേജ് ഒരു ഒ.എം.ആർ. ഡാറ്റാ ഷീറ്റാണ് (പാർട്ട് I). ഇത് നീലയോ, കറുപ്പോ നിറത്തിലെ ബോൾ പോയിന്റ് പേന ഉപയോഗിച്ച് മാത്രമേ പൂരിപ്പിക്കാവൂ.)

3. Make sure that register number is bubbled correctly and completely; no correction is permitted.
(രജിസ്റ്റർ നമ്പർ രേഖപ്പെടുത്തുന്നതിനുള്ള കുമിളകൾ കൃത്യമായും പൂർണ്ണമായും കറുപ്പിച്ചിട്ടുണ്ടെന്ന് ഉറപ്പു വരുത്തുക. തിരുത്തലുകൾ അനുവദനീയമല്ല.)

4. Do not tamper the bar code printed on the OMR sheet and subsequent pages. Tampering of bar code will result in the invalidation of this booklet.
(ഈ പുസ്തകത്തിൽ എവിടെയും പ്രിന്റ് ചെയ്തിരിക്കുന്ന ബാർ കോഡിൽ ഒരു കാരണവശാലും തിരുത്തലുകളോ, മാർക്കുകളോ പാടില്ല. ഇതിനു വിരുദ്ധമായി ചെയ്യുന്ന പക്ഷം ഈ പുസ്തകം അസാധുവാകുന്നതാണ്.)

5. Answers should be written with blue or black ball point pen only.
(ഉത്തരങ്ങൾ നീലയോ, കറുപ്പോ നിറത്തിലെ ബോൾ പോയിന്റ് പേന ഉപയോഗിച്ച് മാത്രമേ എഴുതാവൂ.)

6. Do not write anything outside the margin of space provided for writing the answer and write only one line of answer between two lines.
(പുസ്തകത്തിൽ ഉത്തരം എഴുതുവാൻ നൽകിയിരിക്കുന്ന സ്ഥലത്തിനു വെളിയിൽ യാതൊന്നും തന്നെ എഴുതുവാൻ പാടില്ല. രണ്ടു വരകൾക്കിടയിൽ ഒരു വരി ഉത്തരം മാത്രമേ എഴുതുവാൻ പാടുള്ളൂ.)

7. Rough work should be done only in the specific page provided with.
(റഫ് വർക്കുകൾ ഇതിനായി നൽകിയിരിക്കുന്ന പേജിൽ മാത്രമേ ചെയ്യുവാൻ പാടുള്ളൂ.)

1. Explain the principle of virtual work and discuss its importance in structural analysis. (5 Marks)

2. State and explain the impulse-momentum theorem and its application in analysing collisions. (5 Marks)

3. Estimate atomic packing factor for an HCP unit cell. (5 Marks)

4. Explain how yield strength is related to the grain size of a crystal. (5 Marks)

5. Describe "surface defects" in crystalline materials. (5 Marks)

6. A cantilever of length 2 m carries a UDL of 1.5 kN/m length run over the whole length and a point load of 2 kN at a distance of 0.5 m from the free end. Draw the SFD and BMD for the cantilever. (5 Marks)

7. Write the significance of torsional rigidity in shafts and section modulus in the analysis of beams. (5 Marks)

8. Describe strain gauges and strain rosettes in stress analysis. (5 Marks)

9. The arm of an epicyclic gear train carries two gears A and B with 36 and 45 teeth respectively. Assuming the arm to be rotating at 200 rpm (Anti clockwise), determine the speed and direction of gear B in the following two cases: (5 Marks)

   (i) Gear A is fixed and arm rotates about the centre of A

   (ii) Gear A rotates at 200 rpm (Clockwise)

10. An aircraft cruising at 360 km per hour takes a left turn through a half circle of radius 100 m. The combined mass of engine and propeller is 400 kg with a radius of gyration 20 cm. The engine rotates at 3000 rpm clockwise as viewed from the rear. Determine the gyroscopic couple induced and state its effect on the aircraft. (5 Marks)

11. A uniform rod of mass 'm' and length 'l' is supported at its two ends A and B by vertical springs attached to fixed surfaces. Each spring has a stiffness of 'k'. If the rod AB is hinged at P so that $AP = l/3$ and $PB = 2l/3$, find the natural frequency of the system. (5 Marks)

12. Four parallel springs support a refrigerator unit of mass 100 kg and transmit the vibrations to the foundation. The force transmitted to the foundation is only 12.5% of the impressed force. If the refrigerator operates at 360 rpm, determine the stiffness of each spring needed. (5 Marks)

13. A static load of 60 kN and an alternating load that fluctuates between –10 kN to 90 kN act on a bar of square cross-section. The ultimate strength and the corrected endurance limit of the bar are 500 MPa and 200 MPa. For a factor of safety 2, what would be the dimensions of the square cross-section if Goodman's criterion is applied? (5 Marks)

14. A full journal bearing, 50 mm in diameter and 50 mm long supports a radial load of 2 kN while operating at a speed of 1200 rpm. If it is to be operated at a Sommerfield number of 0.125 when the radial clearance is 0.05 mm, find the viscosity of the oil to be used.

    Also estimate the power loss in the bearing in terms of the resulting coefficient of friction f' (5 Marks)

15. The yield strength of a material used to manufacture a machine component is 700 MPa. Compute the values of factor of safety by applying the maximum principal stress theory, maximum shear stress theory and distortion energy theory for each of the following states of stress expressed through principal coordinate system in MPa. (5 Marks)

(i) $\begin{bmatrix} 400 & 0 & 0 \\ 0 & 400 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

(ii) $\begin{bmatrix} 450 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -50 \end{bmatrix}$

16. The work and heat transfer per degree of temperature change for a closed system is given by $\frac{dW}{dT}=\frac{1}{40}kJ/°C$ and $\frac{dQ}{dT}=\frac{1}{10}kJ/°C$

Calculate the change in internal energy as its temperature increases from 125°C to 245°C. (5 Marks)

17. A heat engine is working in infinitesimal reversible cycle between two heat sources at T_1 and T_2. The temperature of the hot source decreases while that of the sink increases till they become equal. Prove that the overall efficiency of the engine is lower than Carnot efficiency for an engine operating between temperatures T_1 and T_2 although the cycles are reversible. (5 Marks)

18. An ideal diesel engine operates with air as the working substance. Draw the P-V (pressure-volume) and T-s (Temperature-Entropy) diagram for the cycle indicating clearly each of the process with direction. (5 Marks)

19. Define heat balance sheet of an internal combustion engine. What are the values required to compute the heat balance of an internal combustion engine with expressions. (5 Marks)

20. Draw the P-V (Pressure-Volume) and T-s (Temperature-Entropy) diagram of a Rankine cycle. Define Rankine efficiency. (in terms of enthalpy) and how it is estimated? (5 Marks)

21. State Newton's Law of viscosity. What is the effect of temperature on viscosity of water and that of air? (5 Marks)

22. What you mean by boundary layer separation? What is the effect of pressure gradient on boundary layer separation? (5 Marks)

23. Differentiate between Pelton and Francis turbines. (5 Marks)

24. Explain the purpose of providing scroll casing and guide vanes for a reaction turbine. (5 Marks)

25. Define refrigerant. What are the important properties of refringent? (5 Marks)

26. Give the comparisons of vapor compression and absorption refrigeration systems. (5 Marks)

27. Define thermal conductivity. Explain the variation of thermal conductivity with temperature for solids, liquids and gases. (5 Marks)

28. Define Biot number and Fourier number and mention their significance.

29. Differentiate between hot working and cold working processes with suitable examples. (5 Marks)

30. Explain the functions and design considerations of a riser in a casting system. Mention the types of risers. (5 Marks)

31. Compare and contrast forging and extrusion in terms of deformation, tooling, and product characteristics. (5 Marks)

32. Describe the basic principles and differences among welding, brazing, soldering and adhesive bonding. (5 Marks)

33. Explain Taylor's tool life equation and its industrial significance. (5 Marks)

34. Discuss the principle and process requirements of Electrical Discharge Machining (EDM) and mention its applications. (5 Marks)

35. What is interferometry? How is it used for precision measurement? (5 Marks)

36. How exponential smoothing method differs from moving average method of forecasting? Explain these methods with suitable examples. (5 Marks)

37. Explain the components of costs in basic EOQ model? Derive an expression for EOQ and represent it graphically. (5 Marks)

38. How can standard time be determined in work measurement? Explain any three allowances. (5 Marks)

39. Explain north west corner method of solving transportation problem with a suitable example. (5 Marks)

40. What is value analysis? Explain any three types of values that can be attributed to a product. (5 Marks)