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# 23-0004-AB TEST BOOKLET

**Time Allowed: 3 hours** | **PAPER – II** | **Maximum Marks: 100**

## INSTRUCTIONS TO CANDIDATES

*Read the instructions carefully before answering the questions: -*

1. This Test Booklet consists of 16 **(sixteen) pages** and has **60 (sixty) items (questions)**.
2. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS BOOKLET *DOES NOT* HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
3. **Please note that it is the candidate's responsibility to fill in the Roll Number and other required details carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet and the Separate Answer Booklet. Any omission/discrepancy will render the OMR Answer Sheet and the Separate Answer Booklet liable for rejection.**
4. Do not write anything else on the OMR Answer Sheet except the required information. Before you proceed to mark in the OMR Answer Sheet, please ensure that you have filled in the required particulars as per given instructions.
5. Use **only Black Ball Point Pen** to fill the OMR Answer Sheet.
6. This Test Booklet is divided into 3 (three) parts – **Part – I, Part - II** and **Part – III**.
7. All three parts are **Compulsory**.
8. **Part-I consists of Multiple Choice-based Questions.** The answers to these questions have to be marked in the **OMR Answer Sheet** provided to you.
9. **Part-II and Part-III consist of Conventional Essay-type Questions.** The answers to these questions have to be written in the separate **Answer Booklet** provided to you.
10. In Part-I, each item (question) comprises of 04 (four) responses (answers). You are required to select the response which you want to mark on the OMR Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose *ONLY ONE* response for each item.
11. After you have completed filling in all your responses on the OMR Answer Sheet and the Answer Booklet(s) and the examination has concluded, you should hand over to the Invigilator *only the OMR Answer Sheet and the Answer Booklet(s)*. You are permitted to take the Test Booklet with you.
12. **Penalty for wrong answers in Multiple Choice-based Questions:**

THERE WIL BE **PENALTY** FOR WRONG ANSWERS MARKED BY A CANDIDATE.

(i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third** of the marks assigned to the question will be deducted as penalty.

(ii) 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 and there will be same penalty as above to the question.

(iii) If a question is left blank. i.e., no answer is given by the candidate, there will be **no penalty** for that question.

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## PART-I
## (Multiple Choice-based Questions)

*Instructions for Questions 1 to 50:*

- *Attempt all questions. Each question carries 1 mark.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*

*[1 x 50 = 50]*

1. For a reversible cycle, entropy change _____.
   (a) is greater than zero
   (b) is less than zero
   (c) increases at first and then decreases
   (d) is equal to zero

2. Work done is the least in an _____ process.
   (a) Isenthalpic
   (b) Isochoric
   (c) Isothermal
   (d) Isentropic

3. A carburettor is used to supply -
   (a) diesel + air + lubricating oil
   (b) petrol + air + lubricating oil
   (c) petrol + lubricating oil
   (d) petrol + air

4. The 1489 cc, 55 bhp BMC B-series petrol engine used in the Ambassador Car was of -
   (a) Side valve type
   (b) Overhead valve type
   (c) Overhead inlet side exhaust valve type
   (d) F type

5. Consider the following statements -
   The Fourier heat conduction equation $\boldsymbol{Q = -kA\frac{dt}{dx}}$ presumes:
   (1) Steady state conditions
   (2) Constant value of thermal conductivity
   (3) Uniform temperature at the wall surfaces
   (4) One-dimensional heat flow.

   **Which of the above statements are correct? Select the correct answer from the codes given below.**
   (a) 1, 2 and 3
   (b) 1, 2 and 4
   (c) 2, 3 and 4
   (d) 1, 3 and 4

6. Multipass heat exchangers are used to _____.
   (a) reduce the pressure drop
   (b) obtain low heat transfer coefficient
   (c) obtain high heat transfer coefficient
   (d) facilitate very large temperature drop through the tube wall

7. Which dimensionless number has a significant role in forced convection?
   (a) Prandtl number
   (b) Reynolds number
   (c) Mach number
   (d) Peclet number

8. In gas cycle refrigeration system, the throttle valve of a vapour compression refrigerant systems is replaced by:
   (a) Capillary tube
   (b) Expander
   (c) Reverse throttle valve
   (d) None of the above

9. Cooling tower utilises the phenomenon of -
   (a) Evaporative cooling
   (b) Heating and humidification
   (c) Cooling and dehumidification
   (d) Chemical dehumidification

10. Which of the following equations is satisfied by the velocity potential function?
   (a) Laplace equation
   (b) Bernoulli's equation
   (c) Euler's equation
   (d) Reynold's Equation

11. Kinematic viscosity of water at 20°C is -
   (a) 2.0 centistokes
   (b) 1.0 centistoke
   (c) 1.5 centistokes
   (d) 1.8 centistokes

12. The discharge over a broad crested weir is maximum when the depth of flow is:
   (a) $H/2$
   (b) $H/3$
   (c) $2H/3$
   (d) $3H/2$

13. The ratio of average velocity to maximum velocity for steady laminar flow in circular pipe is:

(a) 0.5
(b) 1.0
(c) 1.3
(d) 1.5

14. The dimensions of surface tension $\sigma$ in M-L-T system are -

(a) $MT$
(b) $MT^{-1}$
(c) $MT^{-2}$
(d) $ML^{-1}T^{-2}$

15. For a simply supported beam $AB$ of span $l$, subjected to uniformly varying load - zero at $A$ to $w$ at $B$. The support reaction at $A$ is -

(a) $wl/6$
(b) $wl/3$
(c) $2wl/3$
(d) $2wl$

16. Two close coiled springs of stiffness **S** and **2S** are arranged in series in one case and in parallel in the other case. The ratio of stiffness of spring connected in series to parallel is:

(a) $1/3$
(b) $1/9$
(c) $2/3$
(d) $2/9$

17. The ratio of moment carrying capacity of a circular cross-section beam of diameter $D$ and square cross-section beam of dimension $D$ is:

(a) $\pi/4$
(b) $3\pi/8$
(c) $\pi/3$
(d) $3\pi/16$

18. A hollow circular column of internal diameter $d$ and external diameter $1.5d$ is subjected to compressive load. The maximum distance of the point of application of the load from the center for no tension is -

(a) $d/8$
(b) $13d/48$
(c) $d/4$
(d) $13d/96$

19. A hollow steel shaft of external diameter 100 mm and internal diameter 50 mm is to be replaced by a solid alloy shaft. Assuming the same value of polar modulus for both, the diameter of the solid alloy shaft will be -

(a) $10\sqrt[3]{9375}\ mm$
(b) $10 \times \sqrt[3]{9375 \times 10}\ mm$
(c) $10 \times \sqrt[3]{\frac{9375}{10}}\ mm$
(d) $\sqrt[3]{9375}\ mm$

20. For tangent cam, with roller follower in contact with flank, the acceleration $f$ of the follower is given by -

(a) $f = \omega^2(r_c + r_r)\left(\frac{2-\cos^2\theta}{\cos^3\theta}\right)$

(b) $f = \omega^2(r_c + r_r)\left(\frac{1-\cos^2\theta}{\cos^3\theta}\right)$

(c) $f = \omega^2(r_c + r_r)\left(\frac{1}{\cos^2\theta} - 1\right)$

(d) $f = \omega^2(r_c + r_r)\left(\frac{1}{\cos^3\theta} - 1\right)$

21. If there are several unbalanced masses in a rotor in different planes, the minimum number of balancing masses required is -

(a) one
(b) two
(c) three
(d) four

22. The height of Porter governor with equal arms pivoted at equal distance from the axis of rotation is expressed as -

(a) $h = \left(\frac{m+M}{m}\right)\frac{895}{N}$

(c) $h = \left(\frac{m+M}{m}\right)\frac{895}{N^2}$

(b) $h = \left(\frac{m+M/2}{m}\right)\frac{895}{N^2}$

(d) $h = \left(\frac{m/2+M}{m}\right)\frac{895}{N}$

23. The hour hand and the minute hand are connected in a clock mechanism by means of a -

(a) Simple gear train
(b) epicyclic gear train
(c) Reverted gear train
(d) none of the above

24. Klein's construction is helpful in determining -

(a) acceleration of various parts
(b) only Coriolis acceleration
(c) displacement of various parts
(d) none of the above.

25. Design of shafts made of brittle material is based on _____.

(a) Guest's theory
(b) Rankine's theory
(c) St. Venant's theory
(d) Von Mises theory

26. In thick film hydrodynamic journal bearings, the coefficient of friction _____.
    (a) increases with increase of load
    (b) is independent of friction
    (c) decreases with increase in load
    (d) may increase or decrease with increase in load

27. In spur gears, the circle on which the involute is generated is called the -
    (a) Pitch circle
    (b) Base circle
    (c) Clearance circle
    (d) Dedendum circle

28. If the principal stresses corresponding to a two-dimensional state of stress are $\sigma_1$ and $\sigma_2$. If $\sigma_1$ is greater than $\sigma_2$ and both are tensile, then which one of the following would be the correct criterion for failure by yielding, according to shear stress criterion?
    (a) $\frac{\sigma_1-\sigma_2}{2} = \pm\frac{\sigma_{yp}}{2}$
    (b) $\frac{\sigma_1}{2} = \pm\frac{\sigma_{yp}}{2}$
    (c) $\frac{\sigma_2}{2} = \pm\frac{\sigma_{yp}}{2}$
    (d) $\sigma_1 = \pm 2\sigma_{yp}$

29. Match **List-I** with **List-II** and select the correct answer using the codes given below the lists.

| List-I | List-II |
|---|---|
| A. Interference | 1. Arc of approach, arc of recess, circular pitch. |
| B. Dynamic load on tooth | 2. Lewis' equation. |
| C. Static load | 3. Minimum number of teeth on pinion. |
| D. Contact ratio | 4. Inaccuracies in tooth profile. |

**Codes:**

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 3 | 4 | 1 | 2 |
| (b) | 1 | 2 | 3 | 4 |
| (c) | 4 | 3 | 2 | 1 |
| (d) | 3 | 4 | 2 | 1 |

30. The maximum efficiency for Parson's reaction turbine is given by -
    (a) $\eta_{max} = \frac{\cos\alpha}{1+\cos\alpha}$
    (b) $\eta_{max} = \frac{2\cos\alpha}{1+\cos\alpha}$
    (c) $\eta_{max} = \frac{2\cos^2\alpha}{1+\cos^2\alpha}$
    (d) $\eta_{max} = \frac{1+\cos^2\alpha}{2\cos^2\alpha}$

31. The ratio of useful heat drop to the isentropic heat drop at the exit of nozzle is called -
(a) Condenser Efficiency
(b) Boiler Efficiency
(c) Nozzle Efficiency
(d) Thermal Efficiency

32. The disc and shaft of a reaction turbine rotate _____.
(a) in the same direction as that of the steam jet
(b) in the opposite direction to that of the steam jet
(c) in a direction at right angle to the direction of the steam jet
(d) none of the above

33. The flow of steam at the exit of a divergent nozzle is a _____.
(a) Subsonic flow
(b) Sonic flow
(c) Supersonic flow
(d) None of the above

34. The Mach number at the throat of a correctly designed nozzle is -
(a) Equal to 1
(b) Less than 1
(c) More than 1
(d) None of the above

35. Iron at 20°C is BCC with atoms of atomic radius 0.124 nm. The lattice constant $\alpha$ for the cube edge of the iron unit cell is _____.
(a) 0.2864 nm
(b) 0.3864 nm
(c) 0.4864 nm
(d) 0.5864 nm

36. Match **List-I** with **List-II** and select the correct answer using the codes given below the lists.

| List-I (Alloys) | List-II (Applications) |
|---|---|
| A. Chromel | 1. Journal bearing |
| B. Babbitt metal | 2. Milling cutter |
| C. Nimonic alloy | 3. Thermocouple |
| D. High speed steel | 4. Gas turbine blades |

**Codes:**

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 3 | 1 | 4 | 2 |
| (b) | 3 | 4 | 1 | 2 |
| (c) | 2 | 4 | 1 | 3 |
| (d) | 2 | 1 | 4 | 3 |

37. Ceramic materials that are usually used for piezoelectric applications are:
(a) Alumina, zirconia
(b) Boron carbide, silicon carbide
(c) Barium titanate, lead-zirconate-titanate
(d) Porcelain, fused silica glass

38. Which of the following is not a thermoplastic?
    (a) PVC
    (b) Nylon
    (c) Phenolic
    (d) Acrylic

39. A built-up-edge is formed while machining _____.
    (a) ductile material at high speed
    (b) ductile material at low speed
    (c) brittle material at high speed
    (d) brittle material at low speed

40. **Consider the following statements:**

    MIG welding process uses _____.

    (1) consumable electrode
    (2) non-consumable electrode
    (3) D.C. power supply
    (4) A.C. power supply

    **Which of the above statements are correct? Select the correct answer from the codes given below.**

    (a) 2 and 4 are correct
    (b) 2 and 3 are correct
    (c) 1 and 4 are correct
    (d) 1 and 3 are correct

41. Match **List-I** with **List-II** and select the correct answer using the codes given below the lists.

| List-I (Robot) | List-II (Developed by) |
|---|---|
| A. SCARA | 1. Unimation |
| B. PUMA | 2. IBM |
| C. Aibo Robo Dog | 3. Yamanshi University, Japan |
| D. RS-1 Robot | 4. Sony |

**Codes:**

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 3 | 1 | 4 | 2 |
| (b) | 4 | 1 | 2 | 3 |
| (c) | 3 | 4 | 2 | 1 |
| (d) | 2 | 1 | 4 | 3 |

42. In vertical bed CNC lathe:
    (a) The Bed is vertical.
    (b) The Spindle is vertical.
    (c) Both the Spindle and the bed are vertical.
    (d) The disk type of turret is provided.

43. For increasing the productivity, CNC system can be interface with _____.
    (a) CAD/CAM
    (b) DNC
    (c) FMS
    (d) All of above.

44. Which of the following is a complete determination of the specific technological process steps and their sequence to be followed to produce products at the desired quality, quantity and cost?
    (a) Process planning and routing
    (b) Process selection and Material Planning
    (c) Process cost estimation
    (d) None of the above

45. In PERT, the activity duration follows _____.
    (a) Normal distribution
    (b) Beta distribution
    (c) Binomial distribution
    (d) Poisson distribution

46. ABC analysis deals with -
    (a) analysis of Process chart.
    (b) flow of Material.
    (c) classifying inventory items based on consumption values.
    (d) ordering the schedule job.

47. Which of the following control charts is used to detect small shift in the mean of a process?
    (a) $\bar{X}$ and $R$ chart.
    (b) $\bar{X}$ and $S$ chart.
    (c) Proportion nonconforming chart.
    (d) CUSUM chart.

48. Which one of the following is an effective system for integrating the quality development, quality maintenance and quality improvement efforts of various groups in an organisation so as to enable marketing, engineering, production and service at the most economical levels which allow for full customer satisfaction?
    (a) TQM
    (b) BQM
    (c) IQM
    (d) TTQ

49. A computer receives input in the form of instructions known as _____.
    (a) Data
    (b) Information
    (c) Programs
    (d) Variables

50. Consider the following statements regarding Basic Computer Applications:
    (1) The system software facilitates users with the capabilities of computers to do a specific task whereas application software enables users to efficiently operate the computer system.
    (2) The software is a set of instruction that tells the hardware what to perform and how to perform the requested actions.
    (3) A compiler converts any high-level language program to machine language in one go.
    (4) Adobe page maker is an example of a database management system.

    **Which of the above statements are correct? Select the correct answer from the codes given below.**

    (a) 1 and 3 only.
    (b) 1 and 4 only.
    (c) 2 and 3 only.
    (d) 2 and 4 only.

## PART-II
## (Short Answer-type Questions)

*Instructions for Questions 51 to 56:*

- *Write the answers in short for any 04 (FOUR) questions out of the six.*
- *Each question carries 5 marks.*
- *Candidates are required to give their answers in their own words as far as practicable.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*

*[5 x 4 = 20]*

51. Write down the general energy equation for steady flow system and simplify when applied for the following systems:
    (a) Centrifugal water pump
    (b) Steam nozzle

52. The velocity potential for a two-dimensional flow is -

$$\phi = x(2y - 1)$$

Determine the velocity at the point $P(4, 5)$. Also obtain the value of stream function at this point $P$.

53. Write the assumption taken in Lame's theory of thick cylinder & derive the Lame's Equations.

54. What is the effect of friction on the flow through a steam nozzle? Explain with the help of $h - s$ diagram.

55. The voltage - arc length characteristic of a D.C. arc is given by $V = 20 + 40l$ where $V$ is the arc voltage and $l$ is the length of arc in cm. Determine the open circuit voltage and short circuit current for arc lengths ranging from **3 to 5 mm** and current ranging from **400 to 500 amperes** during welding operation.

56. In an I.C. engine arrangement, the displacement $D$ is given by -

$$D = r\left[(1 - \cos\theta) + \frac{1}{2}\left(\frac{r}{l}\right)\sin^2\theta + \frac{1}{8}\left(\frac{r}{l}\right)^3 \sin^4\theta\right]$$

where, $\theta$ = crank angle.
Write a FORTRAN program to prepare a table for displacement of piston versus the crank shaft angle, for all angles between $0°$ and $360°$ in uniform increments of $10°$.

## PART-III
## (Long Answer-type Questions)

*Instructions for Questions 57 to 60:*

- *Answer any 02 (TWO) questions out of the four.*
- *Each question carries 15 marks.*
- *Candidates are required to give their answers in their own words as far as practicable.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*

*[15 x 2 = 30]*

57. An internally cooled copper conductor of $\mathbf{2\ cm}$ outer radius and $\mathbf{0.75\ cm}$ inner radius carries a current density of $\mathbf{5000\ A/cm^2}$. A constant temperature of $\mathbf{70°C}$ is maintained at the inner surface and there is no heat transfer through insulation surrounding the copper. Set up an equation for temperature distribution through copper. Proceed to calculate the maximum temperature of copper and the radius at which it occurs. Also find the internal heat transfer rate and check that this equals the total energy generation in the conductor. **For copper**: thermal conductivity $\boldsymbol{k = 380\ W/m\ K}$ and the resistivity $\boldsymbol{\rho = 2 \times 10^{-8} m}$.

58. A flat-faced mushroom follower is operated by a uniformly rotating cam. The follower is raised through a distance of $\mathbf{25mm}$ in $\mathbf{120°}$ rotation of the cam, remains at rest for the next $\mathbf{30°}$ and is lowered during further $\mathbf{120°}$ rotation of the cam. The raising of the follower takes place with cycloidal motion and the lowering with uniform acceleration and deceleration. However, the uniform acceleration is $\mathbf{2/3}$ of the uniform deceleration. The least radius of the cam is $\mathbf{25mm}$ which rotates at $\mathbf{300\ r.p.m}$. Draw the cam profile and determine the values of the maximum velocity and maximum acceleration during rising.

59. A gear train transmitting **5 kW** at **1440 rpm** is shown in the following figure-1. The number of teeth on gears **A, B, C,** and **D** are **25, 100, 30,** and **150** respectively. All gears have **5 mm** module and a **20°** full-depth involute profile gear tooth. Calculate the tangential and radial components of forces between gears **A** and **B** and between gears **C** and **D**. Also calculate the resultant reactions at the bearing supports $\mathbf{S_1}$ and $\mathbf{S_2}$.

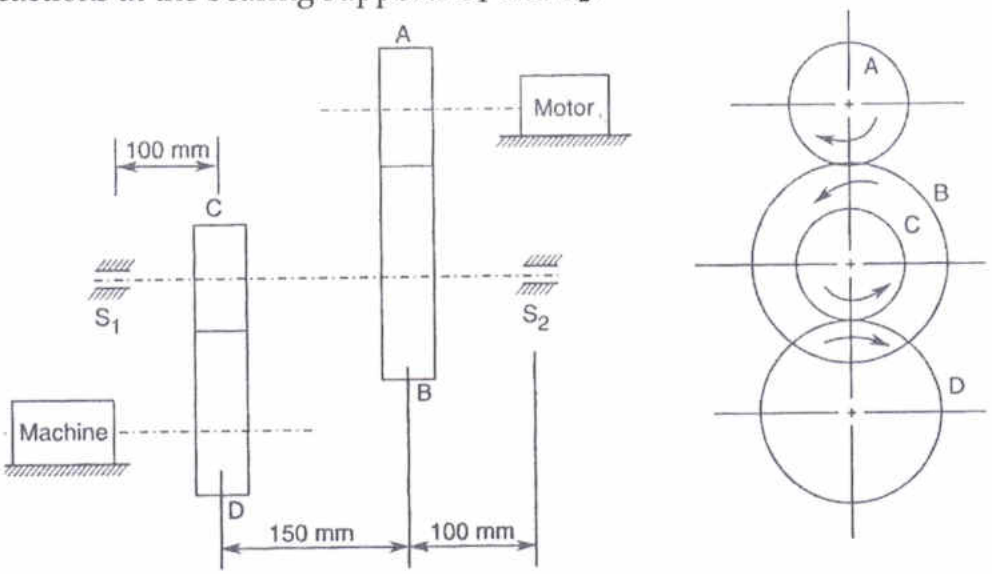


**Figure-1**

60. Calculate the capacity requirement per week for a company, which uses an MRP system. Actual capacity requirement and forecasted demand are given in the tables below. Company plans to adjust capacity when the cumulative deviation exceeds **1/4** of the forecasted average demand per week. Would this system necessitate any adjustment?

**TABLE 1**
**Actual capacity requirement**

| Week 1 | Week 2 | Week 3 | Week 4 | Week 5 |
|---|---|---|---|---|
| 285 | 460 | 350 | 210 | 315 |

**TABLE 2**
**Forecast demand**

| Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 | Week 10 |
|---|---|---|---|---|---|---|---|---|---|
| 200 | 180 | 125 | 465 | 270 | 230 | 280 | 310 | 230 | 190 |

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Space for rough work

Space for rough work