THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA, VADODARA

Ph. D. ENTRANCE TEST (PET) 2023

Signature of Invigilator

Roll. No.

Paper - II
Mechanical Engineering

Maximum Marks: 50 **No. Of Printed Pages: 8**

Instruction for the Candidate:

1. This paper consists of **FIFTY (50)** multiple choice type questions. Each Question carries **ONE (1)** mark.
2. There is no Negative Marking for Wrong Answer.
3. A separate OMR Answer Sheet has been provided to answer questions. Your answers will be evaluated based on your response in the OMR Sheet only. No credit will be given for any answering made in question booklet.
4. Defective question booklet or OMR if noticed may immediately replace by the concerned invigilator.
5. Write roll number, subject code, booklet type, category and other information correctly in the OMR Sheet else your OMR Sheet will not be evaluated by machine.
6. Select most appropriate answer to the question and darken appropriate oval on the OMR answer sheet, with black / blue ball pen only. DO NOT USE PENCIL for darkening. In case of over writing on any answer, the same will be treated as invalid. Each question has exactly one correct answer and has four alternative responses (A), (B), (C) and (D). You have to darken the circle as indicated below on the correct response against each item.
   Example: Ⓐ ● Ⓒ Ⓓ where (B) is correct response.
7. Rough Work is to be done in the end of this booklet.
8. If you write your Name, Roll Number, Phone Number or put any mark on any part of the OMR Answer Sheet, except for the space allotted for the relevant entries, which may disclose your identity, or use abusive language or employ any other unfair means, such as change of response by scratching or using white fluid, you will render yourself liable to disqualification.
9. Calculators, Log tables any other calculating devices, mobiles, slide rule, text manuals etc are NOT allowed in the examination hall. If any of above is seized from the candidates during examination time; he/ she will be immediately debarred from the examination and corresponding disciplinary action will be initiated by the Center Supervisor as deemed fit.
10. DO NOT FOLD or TEAR OMR Answer sheet as machine will not be able to recognize torn or folded OMR Answer sheet.
11. **You have to return the OMR Answer Sheet to the invigilator at the end of the examination compulsorily** and must not carry it with you outside the Examination Hall. You are however, allowed to carry original question booklet on conclusion of examination.

Paper - II
Mechanical Engineering

Note: This paper contains **FIFTY (50)** multiple-choice questions. Each Question carries **ONE (1)** mark.

01) A moving average system is used for forecasting weekly demand. $F_1(t)$ and $F_2(t)$ are sequences of forecasts with parameters m_1 and m_2 , respectively, where m_1 and m_2 ($m_1 > m_2$) denote the numbers of weeks over which the moving averages are taken. The actual demand shows a step increase from d_1 to d_2 at a certain time. Subsequently,
A) Neither $F_1(t)$ nor F_2 (t) will catch up with the value d_2
B) Both sequences $F_1(t)$) and F_2 (t)will reach d_2 in the same period
C) $F_1(t)$will attain the value d_2 before F_2 (t)
D) F_2 (t)will attain the value d_2 before $F_1(t)$

02) Resistance Spot welding of two steel sheets is carried out in a lap joint configuration by using a welding current of 3KA and a weld time of 0.3 second. A molten weld nugget of volume 20 mm^3 is obtained. The effective contact resistance is 150μΩ. The material properties of steel are given as (i) Latent heat of melting 1400KJ/Kg, (ii) Density 8000kg/m^3, (iii) melting temperature 1520^{0}C (iv) Specific Heat 0.5KJ/kg^{0}C. The ambient temperature is 20^{0}C. Find (I) Heat generated (In Joule), (II) Heat in (KJ) dissipated to the base metal will be (Neglecting all other heat losses), (III) Heat (in Joules) used for production weld nugget will be (assuming 100% heat transfer efficiency).
A) 415, 0.016, 324
B) 405, 0.061, 344
C) 450, 0.016, 334
D) 405, 0.061, 354

03) Match the items in column I and column II

Column I	**Column II**
1) Aluminum brake shoe	A) Deep drawing
2) Plastic wear bottle	B) Blow moulding
3) Stainless steel	C) Sand casting
4) Soft Drink Can (aluminium)	D) Centrifugal Casting
	E) Impact Extrusion
	F) Upset forging

A) 1-A, 2-B, 3-F, 4-B
B) 1-C, 2-B, 3-E, 4-A
C) 1-A, 2-B, 3-C, 4-D
D) 1-F, 2-E, 3-B, 4-C

04) A wire of 0.1 mm diameter is drawn from a rod of 15 mm diameter. Dies giving reductions of 20%, 40% and 80% are available. For minimum error in the final size, the number of stages and reduction at each stage, respectively, would be
A) 3 stages and 80% reduction for all the three stages
B) 4 stages and 80% reduction for first three stages followed by a finishing stage of 20% reduction
C) 5 stages and reduction of 80%, 80%, 40%, 40%, 20% in a sequence
D) None of the above

05) In finish machining of an island on a casting with CNC milling machine, an end mill with 10 mm diameter is employed. The corner points of the island are represented by (0, 0), (0, 30), (50, 30) and (50, 0). By applying cutter radius right compensation, the trajectory of the cutter will be
A) (-5, 0), (-5, 35), (55, 35), (55,-5), (-5,-5)
B) (0,-5), (55,-5), (55, 35), (-5, 35), (-5,-5)
C) (5, 5), (5, 25), (45, 25), (45, 5), (5,5)
D) (5, 5), (45, 5), (45, 25), (5, 25), (5,5)

06) A heat exchanger is called 'compact heat exchanger' when it provides surface density more than
A) 700
B) 400
C) 400 for liquid and 700 for gas
D) 700 for liquid and 400 for gas

07) The surface effectiveness correction factor is used in finned tube heat exchangers because
A) The fins are cooler than base tubes
B) The fins block the passage of fluid flow
C) The fins reduce the convective heat transfer coefficient
D) The fin materials always has lower thermal conductivity compared to the tube material

08) The fluid velocity on the shell side of heat exchanger does not depend upon
A) Baffle spacing
B) Shell diameter
C) Tube pitch
D) Shell length

09) The latent heat of vaporization of water at 0^{o}C is
A) Not possible to evaporate
B) 2250 kJ/kg
C) 2501 kJ/kg
D) 336 kJ/kg

10) In which regime/point the heat flux is enhanced the highest in case of flow boiling?
   A) The critical heat flux
   B) Early part of nucleate boiling regime
   C) Heat flux is not enhanced anywhere
   D) Heat flux is enhanced equally in all regimes

11) An assemblage made up of 3 binary links each connected with other two using turning pairs has degree of freedom equal to
   A) -1
   B) 0
   C) 1
   D) 2

12) A link (O_2A) rotates about O_2. The angular velocity of the link is $10\hat{k}$. The link is 100 mm long and makes 0^0 with positive X-axis. What is the velocity of point A?
   A) $(0\hat{\imath} + 1\hat{\jmath})m/s$
   B) $(0\hat{\imath} - 1\hat{\jmath})m/s$
   C) $(-1\hat{\imath} + 1\hat{\jmath})m/s$
   D) $(1\hat{k})m/s$

13) In the process of getting inversions of double slider mechanism, if connecting rod (Coupler) is fixed the mechanism obtained is called
   A) Crank and slotted lever
   B) Oldham Coupling
   C) Elliptical trammel
   D) Grashoff's Coupling

14) Out of the following mechanisms, which one is quick return mechanism
   A) Pantograph
   B) Watt's Mechanism
   C) Scotch Yoke
   D) Offset slider crank mechanism

15) Determine the resultant of the three co-planar forces acting at a point. Force A, 100 N at 60^0 from horizontal axis, Force B, 100 N at -60^0 from horizontal axis and Force C, 100 N at 180^0 from horizontal axis.
   A) 300 N at 0^0 from horizontal axis
   B) 200 N at 180^0 from horizontal axis
   C) 200 N at 0^0 from horizontal axis
   D) 0 N

16) A rigid square plate ABCD is hinged at point A with AB horizontal and ABCD is to be read in counter-clockwise direction. Take ($AB = 100mm$). The forces applied at points B, C and D are $(100\hat{\imath})N$, $(100\hat{\jmath})N$ and $(-100\hat{\jmath})N$. The resultant of these forces is, $\vec{F}_R$ =_____ and the forces at point A for force equilibrium is equal to $\vec{F}_A$ =_____
   A) $\vec{F}_R = (100\hat{\imath})N$, $\vec{F}_A = (100\hat{\imath})N$
   B) $\vec{F}_R = (-100\hat{\imath})N$, $\vec{F}_A = (-100\hat{\imath})N$
   C) $\vec{F}_R = (100\hat{\imath})N$, $\vec{F}_A = (-100\hat{\imath})N$
   D) $\vec{F}_R = (-100\hat{\imath})N$, $\vec{F}_A = (100\hat{\imath})N$

17) A rigid square plate ABCD is hinged at point A with AB horizontal and ABCD is to be read in counter-clockwise direction. Take ($AB = 100mm$). The forces applied at points B, C and D are $(100\hat{\imath})N$, $(100\hat{\jmath})N$ and $(-100\hat{\jmath})N$. The resultant moment due to these forces is equal to
   A) $(10\hat{k})Nm$
   B) $(-10\hat{k})Nm$
   C) $(10\sqrt{2}\hat{k})Nm$
   D) $(-10\sqrt{2}\hat{k})Nm$

18) The relationship of tool life and cutting speed isexpressed as $VT^n = C$. Which of the following isnot true for this relation?
   A) V = cutting speed (m/min), T = temperature(°C)
   B) V = cutting speed (m/min), T = tool life (min)
   C) It is known as Taylor tool life equation
   D) Tool life decreases at high cutting speeds

19) In a rolling operation the thickness of a rectangular piece is reduced from t1 to t2. The radius of the both rolls are equal to R. The angle of bite (α) will be given by
   A) $\alpha = \cos^{-1}(1 - \frac{t1-t2}{2R})$
   B) $\alpha = \cos^{-1}(\frac{t1-t2}{2R})$
   C) $\alpha = \cos^{-1}(1 - \frac{R2}{t1-t2})$
   D) $\alpha = \cos^{-1}(\frac{t1-t2}{2R} - 1)$

20) 10 sets of items selected from an assembly line were found to have the following number of defects, calculates the upper control limit for a 1-Sigma p-chart (to 3 decimal places.

Sample	1	2	3	4	5	6	7	8	9	10
Production defective	0.06	0.06	0.08	0.05	0.04	0.08	0.06	0.04	0.05	0.04

   A) 0.129
   B) 0.133
   C) 0.121
   D) 0.201

21) Which of the following statements is/ are correct?
1) The operating characteristics curve of an acceptance sampling plan shows the ability of the plan to distinguish between good and bad lots.
2) No sampling plan can give complete protection against the acceptance of the defective products.
3) Double sampling gives protection against the acceptance of the defective products.
4) Double sampling results in more inspection than single sampling if the incoming quality is very bad.
5) C- chart has straight line limits and U chart has zig-zag limit.

A) 1, 2,3,4
B) 1,3,4,5
C) 2,3,4,5
D) 1,2,3,5

22) Consider the following input data in case of MRP?
1) Master production schedule
2) Inventory position
3) Machine capacity
4) Details of delivery
5) Bill of Materials

Which of the above are needed for determination of MRP ?

A) 1,2,5
B) 1,2,3
C) 2,3,4
D) 1,3

23) A 2 ton AC has EER value equal to 3.5. If it runs for 8 hours, how many electrical units will be used?

A) 4.6
B) 56
C) 16
D) Need more data

24) If you fill up tap water in a desert (evaporative cooler) and start it, what will happen to the temperature of water?

A) It will move towards the wet bulb temperature
B) It will move towards dew point temperature
C) Water temperature will remain same because this is adiabatic saturation process
D) Water temperature will increase

25) Why are wind turbine blades twisted?

A) To make them more robust
B) To maintain optimum angle of attack
C) To resist centrifugal force
D) To enhance aesthetics

26) Which one of the following is the advantage of steam power plant as compared to gas turbine power plant?

A) Short schedule for design, installation and startup
B) Output is less dependent on ambient temperature
C) Lower pollutant emission
D) Fast starting and loading

27) This number is the ratio of inertia force to the gravity force of flowing fluid

A) Reynolds number
B) Weber number
C) Froude number
D) Euler number

28) For the state of stress given as $\tau_{ij} = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ units, the values of principal stress are:

A) 1,1
B) 1,-1
C) 0,1
D) 0,2

29) In a spring-mass system of mass m and stiffness k, the ends of the spring are securely fixed and mass is attached to intermediate point of spring. The natural frequency of longitudinal vibration of the system

A) is maximum when the mass is attached to the mid- point of the spring
B) is minimum when the mass is attached to the mid- point of the spring
C) decreases as the distance from top end where mass is attached decreases
D) is independent of location of mass

30) The equation of the motion for the free vibration of spring mass system without damping is given by (Where, c = viscous damping co-efficient, m = mass of the vibrating body, k = spring stiffness, F sinωt= harmonic exciting force).

A) $\ddot{x} + \frac{c}{m}\dot{x} + \frac{k}{m}x = 0$
B) $\ddot{x} + \frac{k}{m}x = 0$
C) $\ddot{x} + \frac{c}{m}\dot{x} + \frac{k}{m}x = F\,sin\omega t$
D) $\ddot{x} + \frac{k}{m}x = F\,sin\omega t$

31) The acceleration vector of centre of gravity of a link is written as $\overrightarrow{A_G} = (45\hat{\imath} - 45\hat{\jmath})m/s^2$ and its mass is 10 kg. The inertia force vector can be written as

A) $\vec{F_i} = 63.64\angle 45^0 N$
B) $\vec{F_i} = 127.28\angle 45^0 N$
C) $\vec{F_i} = 63.64\angle 225^0 N$
D) $\vec{F_i} = 127.28\angle 225^0 N$

32) The acceleration vector of centre of gravity of a link is written as $\overrightarrow{A_G} = (50\hat{\imath} - 150\hat{\jmath})m/s^2$ and its mass is 2 kg. The mass moment of inertia is $0.01kgm^2$ and angular acceleration is $(-120\hat{k})rad/s^2$. The inertia force vector will be displaced by _____mm to handle inertia torque.
A) 0.038
B) 0.38
C) 3.8
D) 38

33) The value of theoretical stress concentration factor depends upon
A) material of the part
B) geometry of the part
C) material and geometry of the part
D) none of these

34) The design of thin cylindrical shells is based on
A) hoop stress
B) longitudinal stress
C) arithmetic mean of the hoop and the longitudinal stress
D) geometric mean of the hoop and longitudinal stress

35) Maximize Z= 11X1+4X2
Subject to : 7X1+ 6X2≤84
4X1+2X2≤32 and x1, x2≥0
The values of x1 and x2 which maximizes Z are respectively.
A) 2.4 and 11.2
B) 0 and 14
C) 8 and 0
D) 3 and 10

36) Statement I : In ordinary drop forging with flash , die cavity is properly filled with metal
Statement II: Forging load increases by increasing flash thickness.
A) Both statement I and statement II are individually true and statement II is the correct explanation of statement I
B) Both statement I and statement II are individually true and statement II is NOT the correct explanation of statement I
C) Statement I is true but statement II is false
D) Statement I is false but statement II is true

37) For a certain tool it was that the relationship between cutting speed V and tool life T was as follows : V= $\frac{1540}{2.73+T} + C$, IF for a cutting speed of 80m/min the tool life is 19.27 minutes the cutting speed corresponding to tool life of 6.27 minutes should be
A) 211.11 m /min
B) 201.11m /min
C) 190.11m/min
D) 181.11 m /min

38) Match the following

Column 1		**Column 2**	
I	Jack Pin	1	To guide the drill bit during machining
II	V-locator	2	For accommodating the variation in the distance of the hole from a plane surface
III	Bushes	3	To locate circular or semicircular objects in a jig or a fixture
IV	Diamond Pin	4	To locate work piece whose dimensions are subject to variation

A) I-4, II-3, III-1, IV-2
B) I-1, II-2, III-3, IV-4
C) I-1, II-4, III-3, IV-2
D) I-4, II-3, III-2, IV-1

39) Match the following manufacturing processes with the manufacturing products.

A	Investment casting	1	Turbine rotors
B	Die casting	2	Turbine blades
C	Centrifugal casting	3	Connection rods
D	Drop forging	4	GI Pipes
		5	CI Pipes
		6	Carburetor body

A) a-1,b-2,c-3,d-4
B) a-2,b-3,c-4,d-5
C) a-4,b-6,c-3,d-1
D) a-2,b-6,c-5,d-3

40) The value of universal gas constant is
A) 0.287 kJ/kg K
B) 1.005 kJ/kg K
C) 4.187 kJ/kg K
D) 8.314 kJ/kmol K

41) Which of the following sentences related to reheater in a power plant is wrong:
A) Reheating improves the dryness fraction at outlet of steam turbine
B) Reheating improves efficiency of the power plant
C) More than two reheater stages are not common
D) Reheat temperature is much less than HP turbine inlet temperature

42) Highest pressures and highest flow rates, these two categories are served respectively by:
A) Multistage reciprocating, Rotary
B) Multistage reciprocating, multistage axial
C) Multistage centrifugal, Multistage axial
D) Multistage reciprocating, multistage centrifugal

43) A hydraulic press has a ram of 20 cm diameter and a plunger of 5 cm diameter. It is used for lifting a weight of 32 kN. Find the force required at the plunger.
A) 32 kN
B) 16 kN
C) 8 kN
D) 2 kN

44) The air-fuel ratio in case of compression ignition engine is in the range of
A) 12-18
B) 20-40
C) 40-70
D) 18-70

45) $j\left(\frac{1+j3}{1-j2}\right)^2 =$ _____, $j = \sqrt{-1}$
A) 1
B) 2
C) -2
D) -1

46) The inverse of matrix $A = \begin{bmatrix} 4 & 3 \\ 1 & 2 \end{bmatrix}$ is
A) $(1/5)\begin{bmatrix} 2 & -3 \\ -1 & 4 \end{bmatrix}$
B) $\begin{bmatrix} 1/4 & 1/3 \\ 1 & 1/2 \end{bmatrix}$
C) $(1/5)\begin{bmatrix} -4 & 1 \\ 3 & -2 \end{bmatrix}$
D) $(-1/5)\begin{bmatrix} -2 & 3 \\ 1 & -4 \end{bmatrix}$

47) Pressure p and Volume V of a gas are connected by the equation $pV^{1.4} = k$. What is approximately percentage error in k when the pressure is increased by 4% and volume decreased by 1.5%.
A) 3%
B) -3%
C) 2%
D) -2%

48) The area A of a triangle is given by $A = (1/2)acsin(\emptyset)$, where $\emptyset$ is the angle between the sides a and c. If a is increasing at 0.4 units/s, c is decreasing at 0.8 units/s and $\emptyset$ is increasing at 0.2 units/s, what is the rate of change of area, when a=3 units, c=4 units and $\emptyset = \pi/6$.
A) -0.84 units^2/s
B) 2 units^2/s
C) 0.42 units^2/s
D) 0.84 units^2/s

49) If the ratio of the length of connecting rod to the crank radius is doubled
A) primary unbalanced forces halved
B) primary unbalanced forces doubled
C) secondary unbalanced forces doubled
D) secondary unbalanced forces halved

50) For deviatoric state of stress,
A) First stress invariant is zero.
B) Principal stresses are zero
C) Second stress invariant is zero
D) All of the above

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Rough Work: