Serial No. 63265

QUESTION BOOKLET

A

MECHANICAL ENGINEERING (06)

Time Allowed : 3 Hours
[1 Hour for Objective
2 Hours for Subjective]

Maximum Marks : 200
[100 Marks for Objective
100 Marks for Subjective]

INSTRUCTIONS FOR CANDIDATES

1. This Question Booklet consists of **two** Parts (Objective and Subjective). Candidate has to attempt both the Parts.
2. **In Objective Part, there are 50 questions carrying 2 marks. There is no negative marking for any wrong answer. In Subjective Part, four (4) questions should be answered in which Question No. 1 is compulsory.**
3. Please do not open this Question Booklet until you are told to do so.
4. Candidate must fill up the necessary information in the space provided on the OMR Answer Sheet before commencement of the test.
5. For marking the correct answer, darken one circle by **black or blue** ball-point pen only. Please do not mark on more than one circle. Darkening on more than one circle against an answer will be treated as wrong answer.
6. Do not detach any leaf from this Question Booklet. After the examination, hand over the OMR Answer Sheet to the Room Invigilator.
7. Possession and use of Calculator, Mobile Phone and Pager is prohibited in the Examination Hall.
8. Candidates are informed that evaluation of OMR Sheets will be done by Electronic Machine. So, they should shadow the bubbles of Roll No., Booklet Series and Booklet No. properly, otherwise Machine will not be able to evaluate it. Failure to comply this instruction will be sole responsibility of the candidates.

SEAL

PART—A

(Objective)

1. In a four-bar chain or quadric cycle chain

(A) each of the four pairs is a turning pair

(B) one is a turning pair and three are sliding pairs

(C) two are turning pairs and two are sliding pairs

(D) three are turning pairs and one is a sliding pair

2. When two links are connected by a pin joint, their instantaneous centre lies

(A) on their point of contact

(B) at the centre of curvature

(C) at the centre of circle

(D) at the pin joint

3. For low and moderate speed engines, the cam follower should move with

(A) simple harmonic motion

(B) uniform velocity

(C) uniform acceleration and retardation

(D) cycloidal motion

4. A porter governor is a/an

(A) pendulum-type governor

(B) deadweight governor

(C) spring-loaded governor

(D) inertia governor

5. In gear trains, if the axes of the first and last wheels are coaxial, then the train is known as

(A) simple train of wheels

(B) compound train of wheels

(C) reverted gear train

(D) epicyclic gear train

6. In a turning moment diagram, the variations of energy above and below the mean resisting torque is called

(A) fluctuation of energy

(B) maximum fluctuation of energy

(C) coefficient of fluctuation of energy

(D) dissipation of energy

7. If the rotating mass of a rim-type flywheel is distributed on another rim-type flywheel whose mean radius is half of the mean radius of the former, then the energy stored in the latter at the same speed will be

(A) four times the first one

(B) same as the first one

(C) one-fourth of the first one

(D) one and half times the first one

8. The unbalanced force due to reciprocating masses

(A) varies in magnitude but constant in direction

(B) varies in direction but constant in magnitude

(C) varies in both magnitude and direction

(D) constant in both direction and magnitude

9. In steady-state forced vibrations, the amplitude of vibrations at resonance is —— damping coefficient.

(A) equal to

(B) directly proportional to

(C) inversely proportional to

(D) independent of

10. In a butt welded joint, the size of weld is —— the throat of the weld

(A) 0·5 time

(B) equal to

(C) $\sqrt{2}$ times

(D) double

11. A screw is specified by its

(A) major diameter

(B) minor diameter

(C) pitch

(D) pitch diameter

12. The shock-absorbing capacity of a bolt may be increased by

(A) increasing its shank diameter

(B) decreasing its shank diameter

(C) tightening the bolt properly

(D) making the shank diameter equal to core diameter of the thread

13. In a steam engine, the piston rod is usually connected to the cross-head by means of a/an

(A) knuckle joint

(B) cottered joint

(C) Oldham's coupling

(D) universal joint

14. The shear stress at a point in a shaft subjected to a torque is

(A) directly proportional to the 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) directly proportional to the applied torque and polar moment of inertia

(D) inversely proportional to the applied torque and polar moment of inertia

15. When the speed of belt increases

(A) the coefficient of friction between the belt and pulley increases

(B) the coefficient of friction between the belt and pulley decreases

(C) the power transmitted will decrease

(D) the power transmitted will increase

16. The effective stress in wire ropes during normal working is equal to the stress due to

(A) axial load plus stress due to bending

(B) acceleration/retardation of masses plus stress due to bending

(C) axial load plus stress due to acceleration/retardation

(D) bending plus stress due to a acceleration/retardation

17. The backlash for spur gear depends upon

(A) module

(B) pitch line velocity

(C) tooth profile

(D) Both (A) and (B)

18. In gears, the contact ratio is the ratio of

(A) length of path of contact to the circular pitch

(B) length of arc of contact to the circular pitch

(C) length of arc of approach to the circular pitch

(D) length of arc of recess to the circular pitch

19. The Young's modulus of a material is 125 GPa and Poisson's ratio is 0·25. The modulus of rigidity of the material is

(A) 50 GPa

(B) 30 GPa

(C) 5 GPa

(D) 500 GPa

20. A body is subjected to a tensile stress of 1200 MPa on one plane and another tensile stress of 600 MPa on a plane at right angles to the former. It is also subjected to a shear stress of 400 MPa on the same planes. The maximum normal stress will be

(A) 400 MPa

(B) 500 MPa

(C) 900 MPa

(D) 1400 MPa

21. 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 modulus

22. The rectangular beam A has a length l, width b and depth d. Another beam B has the same length and width but depth is double that of A. The elastic strength of beam B will be —— as compared to beam A.

(A) same

(B) double

(C) one-fourth

(D) four times

23. When a shaft of diameter D is subjected to a twisting moment T and bending moment M, then equivalent bending moment M_e is given by

(A) $\sqrt{M^2+T^2}$

(B) $\sqrt{M^2-T^2}$

(C) $\frac{1}{2}\left(M+\sqrt{M^2+T^2}\right)$

(D) $\frac{1}{2}\left(M-\sqrt{M^2+T^2}\right)$

24. A column is said to be a short column, when

(A) its length is very small

(B) its cross-sectional area is small

(C) the ratio of its length to the least radius of gyration is less than 80

(D) the ratio of its length to the least radius of gyration is more than 80

25. In a tensile test, when a material is stressed beyond elastic limit, the tensile strain —— as compared to the stress.

(A) decreases slowly

(B) increases slowly

(C) decreases more quickly

(D) increases more quickly

26. The property of a material necessary for forgings, in stamping images on coins and in ornamental work is

(A) elasticity

(B) plasticity

(C) ductility

(D) malleability

27. The percentage of carbon in cast iron varies from

(A) 0·1 to 0·5

(B) 0·5 to 1·0

(C) 1·0 to 1·7

(D) 1·7 to 4·5

28. Steel containing 0·8 to 1·5 percent carbon, is known as

(A) mild steel

(B) dead-mild steel

(C) medium-carbon steel

(D) high-carbon steel

29. The hardness of steel increases if it contains

(A) pearlite

(B) ferrite

(C) cementite

(D) martensite

30. A steel is heated at about 875 °C where the structure consists of entirely austenite. It is then cooled suddenly at a temperature of about 250 °C–520 °C. This process of heat treatment is known as

(A) normalising

(B) annealing

(C) austempering

(D) martempering

31. Bronze is an alloy of

(A) copper and zinc

(B) copper and tin

(C) copper, tin and zinc

(D) copper and chromium

32. Thermosetting plastics are those materials which

(A) are formed to shape under heat and pressure and results in a permanently hard product

(B) do not become hard with application of heat and pressure

(C) are flexible and can withstand considerable wear under suitable conditions

(D) are used as a friction lining for clutches and brakes

33. In a centrifugal casting method

(A) core is made of sand

(B) core is made of ferrous material

(C) core is made of non-ferrous metal

(D) no core is used

34. Which of the following statements is correct for orthogonal cutting system?

(A) The cutting edge of the tool is perpendicular to the direction of tool travel.

(B) The cutting edge clears the width of the workpiece on either ends.

(C) The chip flows over the tool face and the direction of the chip flow velocity is normal to the cutting edge

(D) All of the above

35. Continuous chips with built-up edge are formed during the machining of

(A) brittle materials

(B) ductile metals

(C) hard metals

(D) soft metals

36. The correct sequence of tool materials in increasing order of their ability to retain their hot hardness is

(A) carbide, ceramic, cermet, borazon

(B) ceramic, carbide, borazon, cermet

(C) cermet, carbide, ceramic, borazon

(D) borazon, ceramic, carbide, cermet

37. It is desired to preform the operations like drilling, reaming, counterboring, etc., on a work-piece. Which of the following machines will be used?

(A) Sensitive drilling machine

(B) Radial drilling machine

(C) Gang drilling machine

(D) Multiple spindle drilling machine

38. In centreless grinding workpiece, centre will be

(A) above the line joining the two-wheel centres

(B) below the line joining the two-wheel centres

(C) on the line joining the two-wheel centres

(D) at the intersection of the line joining the wheel centres with the plane of the workpiece

39. Internal gears can be made by

(A) hobbing

(B) shaping with pinion cutter

(C) shaping with rack cutter

(D) milling

40. The consumable electrode is used in

(A) carbon arc welding

(B) submerged arc welding

(C) TIG arc welding

(D) MIG arc welding

41. Any number of equal divisions on the periphery of a circle can be obtained on a milling machine by

(A) direct indexing

(B) simple indexing

(C) compound indexing

(D) differential indexing

42. A jig is defined as a device which

(A) holds and locates a work-piece and guides and controls one or more cutting tools

(B) holds and locates a workpiece during an inspection or for a manufacturing operation

(C) is used to cheek the accuracy of a workpiece

(D) All of the above

43. A diamond locating pin is used in jigs and fixtures because

(A) diamond is very hard and wear resistant

(B) it occupies very little space

(C) it helps in assembly with tolerance on centre distance

(D) it has a long life

44. Which one of the following techniques is used for determining allowances in time study?

(A) Acceptance sampling

(B) Linear regression

(C) Performance rating

(D) Work sampling

45. If F is the fixed cost, V is the variable cost per unit (or total variable costs) and P is the selling price of each unit (or total sales value), then break-even point is equal to

(A) $\frac{F \times V}{P}$

(B) $\frac{F \times P}{V}$

(C) $\frac{F}{1+\frac{V}{P}}$

(D) $\frac{F}{1-\frac{V}{P}}$

46. Slack represents the difference between the

(A) earliest completion time and latest allowable time

(B) latest allowable time and earliest completion time

(C) earliest completion time and normal expected time

(D) latest allowable time and normal allowable time

47. The type of organisation preferred for a steel industry is

(A) line organisation

(B) functional organisation

(C) line and staff organisation

(D) line, staff and functional organisation

48. In order to avoid excessive manipulation of facilities, the layout preferred is

(A) product layout

(B) process layout

(C) group layout

(D) static layout

49. Which one of the following charts gives simultaneously information about the progress of work and machine tooling?

(A) Process chart

(B) Machine load chart

(C) Man-machine chart

(D) Gantt chart

50. In value engineering, important consideration is given to

(A) customer satisfaction

(B) function concept

(C) profit maximisation

(D) cost reduction

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MECHANICAL ENGINEERING (06)

PART—B

(Subjective)

Full Marks : 100 *Time* : 2 hours

The figures in the margin indicate full marks for the questions

Candidates are required to answer **four** questions, of which Question No. **1** is compulsory

1. Answer any *five* of the following questions : 5×5=25

(a) A steel bar of 40 mm × 40 mm square cross-section is subjected to an axial compressive load of 200 kN. If the length of the bar is 2 m and Young's modulus of elasticity (E) = 200 GPa. What will be the elongation of the bar?

(b) The state of stress at a point P in a two-dimensional loading is such that the Mohr's circle is a point located at 175 MPa on the positive normal stress axis. Determine the maximum and minimum principle stresses respectively from the Mohr's circle.

(c) A planar mechanism has 8 links and 10 rotary joints. Find out the number of degrees of freedom of the mechanism by using Gruebler's criterion.

(d) An instrument vibrates with frequency of 1 Hz when there is no damping. When the damping is provided, the frequency of damped vibration was observed to the 0·9 Hz. What will be the damping factor?

(e) A gear set has a pinion with 20 teeth and a gear with 40 teeth. The pinion runs at 30 r.p.s. and transmits a power of 20 kW. The teeth are on the 20° full depth system and have a module of 5 mm. The length of the line of action is 19 mm. Find out the centre distance for the above gear set in mm.

* * *

(f) What is the difference between elasticity and plasticity?

(g) "Natural sand is often not suitable for the moulding purposes." Do you agree with the statement? Justify your answer.

(h) State the advantages and limitations of *(i)* arc welding, *(ii)* gas welding and *(iii)* resistance welding.

2. Answer the following questions : 5×5=25

(a) From a raw material of 100 mm length and 10 mm diameter, a component having length 100 mm and diameter 8 mm is to be produced using a cutting speed of 31·41 m/min and a feed rate of 0·7 mm/rev. How many times we have to resharpen or regrind, if 1000 workpieces are to be produced? In the Taylor's tool-life equation, use constants as $n = 1 \cdot 2$ and $c = 180$.

(b) What material is normally used for manufacturing the bed of a lathe machine and why?

(c) Why are the centre used at headstock called live centre and the centre used at tailstock called dead centre?

(d) Explain the differences between open-loop and closed-loop control system.

(e) Why is iron-carbon equilibrium diagram drawn up to 6·7 wt % of carbon?

3. Answer the following questions : 5×5=25

(a) A steel rod having 10 mm diameter and 1·5 m length is subjected to an axial pull of 1 kN. Find *(i)* stress, *(ii)* strain and *(iii)* elongation. Assume modulus of elasticity $E = 205$ GPa.

(b) Why is the yield strength of a material considered in mechanical engineering design? Explain.

(c) "Fatigue is more dangerous than static or impact load." Do you agree with the statement? Justify your answer.

(d) Using the Taylor's equation for tool life and taking $n = 0 \cdot 5$ and $c = 300$, calculate the change in tool life when the cutting speed is reduced by 25%.

(e) *ABC* Ltd. is engaged in the manufacture of chairs. The cost of land, building and machinery is Rs 10,00,000. The cost of wood and labour for each chair is Rs 400 and the selling price is Rs 600. Find out the minimum number of chairs to be manufactured so that neither profit nor loss is incurred by *ABC* Ltd.

4. Answer the following questions : 5×5=25

(a) The sum of diameters of two pulleys *A* and *B* connected by belt is 1000 mm. If they run at 1500 and 3000 r.p.m. respectively, determine the diameter of each pulley.

(b) Why are gear drives called positively driven?

(c) A certain machine requires a torque of $(500 + 50 \sin\theta)$ kN-m to derive it, where θ is the angle of rotation of shaft measured from certain datum. The machine is directly coupled to an engine which produces a torque $(500 + 50 \sin 2\theta)$ kN-m in a cycle. How many times the value of torque of machine and engine will be identical?

(d) A ball bearing operating at a load F, has 8000 hours of life. What is the life of the bearing, in hour, when the load is doubled to 2F?

(e) Twenty-degree full depth involute profiled 19-tooth pinion and 37-tooth gear are in mesh. If the module is 5 mm, what will be the centre distance between the gear pair?

5. Answer the following questions : 5×5=25

(a) A natural feed journal bearing of diameter 50 mm and length 50 mm operating at 20 revolution/second carries a load of 2·0 kN. The lubricant used has a viscosity of 20 MPas. The radial clearance is 50 μm. Find out the Sommerfeld number for the bearing.

(b) You have an annealed part made of high-carbon steel. Which heat treatment(s) could be used to harden its surface?

(c) Write the differences between hot working and cold working processes.

(d) What is the role of carbon percentage in eutectic and eutectoid points in iron-carbon phase diagram?

(e) Discuss the characteristics of *(i)* martensite and *(ii)* pearlite with respect to iron-carbon phase diagram.

6. Answer the following questions : 5×5=25

(a) The demand and forecast for April are 12000 and 10275 respectively. Using single-exponential smoothening method, (smoothening coefficient = 0·25), what is forecast for the month of May?

(b) What are the differences between push and pull production systems? Write the examples of each system.

(c) A machine is purchased for Rs 32,000 and its assumed life is 20 years. The scrap value at the end of its life is Rs 8,000. If the depreciation is charged by the diminishing balance method, then what is the percentage reduction in its value at the end of the first year?

(d) Write in short key features of MRP system.

(e) Write the differences between product layout and process layout with their suitable examples.

7. Answer the following questions : 5×5=25

(a) Which of the two tests, tension and compression, requires higher capacity of testing machine and why?

(b) Does corrosion have any beneficial effects in manufacturing? Explain.

(c) What is the significance of decarburisation? Give some examples.

(d) Why is the tool-life graphs plotted on a log-log graph?

(e) Calculate the time required to drill a 25 mm diameter hole in a workpiece having thickness of 60 mm to the complete depth. The cutting speed is 14 m/min and feed is 0·3 mm/rev. Assume length of approach and over travel total as 5 mm.

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SPACE FOR ROUGH WORK

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SEAL