

ENGINEERING SERVICES
EXAMINATION-2016

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

T.B.C. : B-HUF-P-OEB

Test Booklet Series

Serial No.

0074245

TEST BOOKLET
MECHANICAL ENGINEERING



Paper—II

Time Allowed : Two Hours

Maximum Marks : 200

INSTRUCTIONS

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 A COMPLETE TEST BOOKLET.
2. Please note that it is the candidate's responsibility to encode and fill in the Roll Number and Test Booklet Series A, B, C or D carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet. Any omission/discrepancy will render the Answer Sheet liable for rejection.
3. You have to enter your Roll Number on the Test Booklet in the Box provided alongside. *DO NOT* write anything else on the Test Booklet.
4. This Test Booklet contains 120 items (questions). Each item comprises four responses (answers). You will select the response which you want to mark on the 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.
5. You have to mark all your responses *ONLY* on the separate Answer Sheet provided. See directions in the Answer Sheet.
6. All items carry equal marks.
7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.
8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator *only the Answer Sheet*. You are permitted to take away with you the Test Booklet.
9. Sheets for rough work are appended in the Test Booklet at the end.
10. **Penalty for wrong answers :**

THERE WILL 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 that 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 that 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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1. Consider the following motions :

1. Piston reciprocating inside an engine cylinder
2. Motion of a shaft between foot-step bearings

Which of the above can rightly be considered as successfully constrained motion?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

2. A rotor weighing 2 kN is supported on bearings A and B which are 1 m apart. The centre of mass of the rotor is at a distance 0.4 m from bearing A. It is observed that there is an unbalanced couple of magnitude 300 N-m which leaves the shaft balanced statically. The dynamic reactions at the supports will be

- (a) 800 N and 800 N
- (b) 300 N and 800 N
- (c) 800 N and -300 N
- (d) 300 N and -300 N

3. A cam is a mechanical member used to impart a desired motion to a follower by direct contact. Which one of the under-listed follower motion types will produce the least jerk to the system?

- (a) Simple harmonic
- (b) Constant acceleration and deceleration
- (c) Constant velocity
- (d) Cycloidal

4. In a circular arc cam with a roller follower, acceleration of the follower depends on

1. cam speed and location of centre of circular arc
2. roller diameter and radius of circular arc

Which of the above is/are correct?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

5. A manufacturing company is selling a product for ₹ 15 per unit with variable cost of ₹ 10 per unit. The fixed cost of the asset is ₹ 50,000. How many units should be produced to breakeven?

- (a) 2000
- (b) 5000
- (c) 8000
- (d) 10000

6. In a crank and slotted lever quick return motion mechanism, the distance between the fixed centres is 200mm. The lengths of the driving crank and the slotted bar are 100 mm and 500mm, respectively. The length of the cutting stroke is

- (a) 100 mm
- (b) 300 mm
- (c) 500 mm
- (d) 700 mm

7. A gear of 28 cm pitch circle diameter has 40 teeth. The circular pitch will nearly be

- (a) 11 mm/tooth
- (b) 22 mm/tooth
- (c) 33 mm/tooth
- (d) 44 mm/tooth

8. Consider the following statements regarding gear tooth designing for gear drive :

1. Tooth profiles not designed as per 'law of gearing' will cause vibration and impact problems even at low speed.
2. As the gears go through their mesh, the pitch point must remain stationary on the line of centres.
3. In a correctly designed tooth profile, the line of action of successive instantaneous points of contact will pass through the stationary pitch point.

Which of the above statements are correct?

- (a) 1, 2 and 3
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 2 and 3 only

9. The flywheel of a steam engine has a radius of gyration of 1 m and mass 2000 kg. The starting torque of the engine is 2000 N-m. The kinetic energy of the flywheel after 10 seconds from start is

- (a) 75 kN-m
- (b) 100 kN-m
- (c) 125 kN-m
- (d) 150 kN-m

10. Consider two shafts connected with two gears as per the following options :

1. One on each shaft
2. Through an intermediate gear mounted on an intermediate shaft, and every shaft having one gear only
3. Through an intermediate gear mounted on an intermediate shaft, with the intermediate shaft having two gears, whereas the other shafts have one gear each

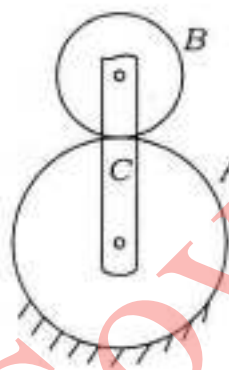
Which of the above represent(s) a simple gear train?

- (a) 1 only
- (b) 1 and 2 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

11. A riveting machine is driven by a constant-torque 3 kW motor. The moving parts including the flywheel are equivalent to 150 kg at 0.6 m radius. One riveting operation takes 1 second and absorbs 10000 N-m of energy. The speed of the flywheel is 300 r.p.m. before riveting. What is the speed (to nearest 10 r.p.m.) after riveting and what is the number of rivets that can be closed per minute?

- (a) 260 r.p.m. and 18
 (b) 290 r.p.m. and 15
 (c) 360 r.p.m. and 18
 (d) 390 r.p.m. and 15

12. With respect to the epicyclic gear train shown in the figure below, A has 75 teeth and B has 25 teeth; A is fixed and arm C makes 5 revolutions :



The number of revolutions made by B is

- (a) 10
 (b) 15
 (c) 20
 (d) 25

13. The equation of motion of a linear vibratory system with a single degree of freedom is

$$4\ddot{x} + 9\dot{x} + 16x = 0$$

The critical damping coefficient for the system is

- (a) 32
 (b) 16
 (c) 8
 (d) 4

14. Which one of the following statements is correct?

- (a) The product of diametral pitch and circular pitch is equal to unity.
 (b) The pressure angle for involute gears depends upon the size of teeth.
 (c) In a gear having involute teeth, the normal to the involute is a tangent to the base circle.
 (d) For commercially cut gears, the limiting pitch line velocity is 60 m/min.

15. The thickness of the continuous weld used for connecting a horizontal square bar of 150 mm size and of cantilevered length 500 mm to a vertical plate, with the bar carrying a 25 kN vertical load at its outer tip, given that the permissible direct shear stress of the weld is 20 N/mm^2 , is

- (a) 3 mm
 (b) 4 mm
 (c) 5 mm
 (d) 6 mm

- 16.** A shaft of 50 mm diameter transmits a torque of 800 N-m. The width of the rectangular key used is 10 mm. The allowable shear stress of the material of the key being 40 MPa, the required length of the key would be
- (a) 60 mm
(b) 70 mm
(c) 80 mm
(d) 90 mm
- 17.** A governor is said to be hunting if the speed of the engine
- (a) remains constant at the mean speed
(b) is above the mean speed
(c) is below the mean speed
(d) fluctuates continuously above and below the mean speed
- 18.** The diameter of the pin in a bushed pin type flexible coupling is to be increased for the purpose of
- (a) higher stress due to shear
(b) keeping the magnitude of bending moment small by reducing the unsupported length of the pin
(c) fitting the pin in the bush
(d) reducing the thickness of the flange
- 19.** The problem of interference in involute profile gears can be overcome by which one of the following means?
- (a) Decreasing the centre distance
(b) Using composite profile with cycloidal curve at the root of the tooth
(c) Using stub teeth of height more than the full depth teeth
(d) Proper lubrication
- 20.** The bearing modulus for a bearing is 1628. What is the bearing characteristic number considered for bearing design?
- (a) 1628
(b) 3256
(c) 4884
(d) 6512

21. Two shafts of diameter 30 mm each are connected by a flange coupling. Six bolts, each of diameter 8 mm, are used on a pitch circle of diameter 90 mm. If the allowable shear stress of the bolt material is 80 MPa, what is the torque-transmitting capacity of the bolts to the nearest 10 units?
- (a) 780 N-m
(b) 950 N-m
(c) 1090 N-m
(d) 1250 N-m
22. While selecting the elements of power transmission with speed reduction, the order of preference based on a minimum cost is
- (a) spur gear, belt pulley, worm and worm wheel
(b) belt pulley, spur gear, worm and worm wheel
(c) worm and worm wheel, spur gear, belt pulley
(d) worm and worm wheel, belt pulley, spur gear
23. A solid shaft is designed to transmit 100 kW while rotating at N r.p.m. If the diameter of the shaft is doubled and is allowed to operate at $2N$ r.p.m., the power that can be transmitted by the latter shaft is
- (a) 200 kW
(b) 400 kW
(c) 800 kW
(d) 1600 kW
24. What shall be the centre distance between the axes of pinion and gear when a 20° full-depth involute profile pinion with 20 teeth meshes with a gear that has 50 teeth for a module of 6 mm?
- (a) 70 mm
(b) 140 mm
(c) 210 mm
(d) 280 mm
25. The diameter of a shaft to transmit 25 kW at 1500 r.p.m., given that the ultimate strength is 150 MPa and the factor of safety is 3, will nearly be
- (a) 12 mm
(b) 16 mm
(c) 20 mm
(d) 26 mm
26. A thick lubrication is
- (a) a stable lubrication and there is no metal to metal contact
(b) a stable lubrication because there is some amount of metal to metal contact
(c) an unstable lubrication because there is some amount of metal to metal contact
(d) an unstable lubrication because there is no metal to metal contact

27. A journal bearing sustains a radial load of 3672 N. The diameter of the bearing is 50 mm and the length is 0.1 m. The diametral clearance is 0.1 mm and the shaft rotates at 500 r.p.m. If the absolute viscosity of the oil is 0.06 kg/m-s, the value of Sommerfeld number is

- (a) 5.2×10^6
 (b) 10.3×10^6
 (c) 15.2×10^6
 (d) 20.3×10^6

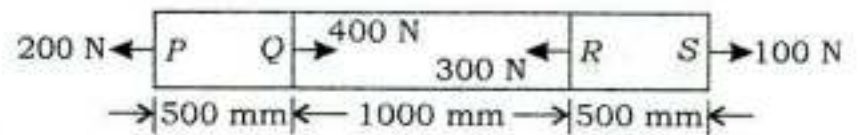
28. If the dynamic load capacity of a ball bearing is increased to 1.5 times its earlier value without changing its equivalent load, the life of the bearing increases to

- (a) 6.4 times its earlier life
 (b) 5.2 times its earlier life
 (c) 4.2 times its earlier life
 (d) 3.4 times its earlier life

29. The speed of the crankshaft is found to vary between 120 r.p.m. and 150 r.p.m. during one cycle of operation. What is the coefficient of fluctuation of speed?

- (a) 0.40
 (b) 0.31
 (c) 0.22
 (d) 0.13

30. A steel rod of cross-sectional area 10 mm^2 is subjected to loads at points P, Q, R and S as shown in the figure below :



If $E_{\text{steel}} = 200 \text{ GPa}$, the total change in length of the rod due to loading is

- (a) $-5 \mu\text{m}$
 (b) $-10 \mu\text{m}$
 (c) $-20 \mu\text{m}$
 (d) $-25 \mu\text{m}$

31. The state of stress at a point when completely specified enables one to determine the

1. maximum shearing stress at the point
2. stress components on any arbitrary plane containing that point

Which of the above is/are correct?

- (a) 1 only
 (b) 2 only
 (c) Both 1 and 2
 (d) Neither 1 nor 2

32. A body is subjected to a direct tensile stress of 300 MPa in one plane accompanied by a simple shear stress of 200 MPa. The maximum normal stress on the plane will be
- (a) 100 MPa
(b) 200 MPa
(c) 300 MPa
(d) 400 MPa
33. A hub is press fitted on a shaft. An element in the hub is subjected to a radial compressive stress of 50 N/mm^2 and hoop stress of 75 N/mm^2 . If the hub is made of 30C8 steel with yield strength, $\sigma_y = 350 \text{ N/mm}^2$, what is the factor of safety using maximum shear stress theory?
- (a) 2.8
(b) 3.6
(c) 4.2
(d) 5.6
34. The state of stress at a point in a loaded member is $\sigma_x = 400 \text{ MPa}$, $\sigma_y = -400 \text{ MPa}$ and $\tau_{xy} = \pm 300 \text{ MPa}$. The principal stresses σ_1 and σ_2 are
- (a) 300 MPa and -700 MPa
(b) 400 MPa and -600 MPa
(c) 500 MPa and -500 MPa
(d) 600 MPa and -400 MPa
35. A circular steel rod of 20 cm^2 cross-sectional area and 10 m length is heated through 50°C with ends clamped before heating. Given, $E = 200 \text{ GPa}$ and coefficient of thermal expansion, $\alpha = 10 \times 10^{-6} / ^\circ\text{C}$, the thrust thereby generated on the clamp is
- (a) 100 kN
(b) 150 kN
(c) 200 kN
(d) 250 kN
36. Two steel rods of identical length and material properties are subjected to equal axial loads. The first rod is solid with diameter d and the second is a hollow one with external diameter D and internal diameter 50% of D . If the two rods experience equal extensions, the ratio of $\frac{d}{D}$ is
- (a) $\frac{3}{4}$
(b) $\frac{\sqrt{3}}{2}$
(c) $\frac{1}{2}$
(d) $\frac{1}{4}$
37. A steel rod 10 m long is at a temperature of 20°C . The rod is heated to a temperature of 60°C . What is the stress induced in the rod if it is allowed to expand by 4 mm, when $E = 200 \text{ GPa}$ and $\alpha = 12 \times 10^{-6} / ^\circ\text{C}$?
- (a) 64 MPa
(b) 48 MPa
(c) 32 MPa
(d) 16 MPa

38. A metal piece under the stress state of three principal stresses 30, 10 and 5 kg/mm^2 is undergoing plastic deformation. The principal strain rates will be in the proportions of
- 15, -5 and -10
 - 15, 5 and -10
 - 15, 5 and 10
 - 15, -5 and 10
39. An isotropic elastic material is characterized by
- two independent moduli of elasticity along two mutually perpendicular directions
 - two independent moduli of elasticity along two mutually perpendicular directions and Poisson's ratio
 - a modulus of elasticity, a modulus of rigidity and Poisson's ratio
 - any two out of a modulus of elasticity, a modulus of rigidity and Poisson's ratio
40. The Miller indices of a material in a plane are proportional to
- the reciprocal of numerical parameters of the intercepts
 - the square of unit cell dimensions
 - the intercepts of the planes on the coordinate axes
 - the interplanar spacing
41. Endurance limit is of primary concern in the design of a/an
- rotating shaft
 - industrial structure
 - column
 - machine base
- Which of the above is/are correct?
- 1 only
 - 2 only
 - 3 and 4 only
 - 1, 2, 3 and 4
42. A simply supported beam of rectangular cross-section is under transverse loading. Regarding the shear stress distribution across any section, the ratio of maximum shear stress to mean shear stress is
- 1.5
 - 2.5
 - 3.5
 - 4.5
43. Two beams, one having a square cross-section and another a circular cross-section, are subjected to the same amount of bending moment. If the cross-sectional area as well as the material of both the beams are the same, then
- both the beams will experience the same amount of deformation
 - the circular beam experiences more extreme flexural stress than the square one
- Which of the above is/are correct?
- 1 only
 - 2 only
 - Both 1 and 2
 - Neither 1 nor 2

44. A coil-spring of stiffness k is cut exactly at the middle and the two springs thus made are arranged in parallel to take up together a compressive load. The equivalent stiffness of the two springs is
- (a) $0.25k$
 (b) $0.5k$
 (c) $2k$
 (d) $4k$
45. Two solid shafts A and B are made of the same material. Shaft A is of 50 mm diameter and shaft B is of 100 mm diameter. The strength of shaft B is
- (a) 2 times as that of shaft A
 (b) 4 times as that of shaft A
 (c) 6 times as that of shaft A
 (d) 8 times as that of shaft A
46. A closely-coiled helical spring is made of 10 mm diameter steel wire, with the coil consisting of 10 turns with a mean diameter 120 mm. The spring carries an axial pull of 200 N. What is the value of shear stress induced in the spring neglecting the effect of stress concentration and of deflection in the spring, when the modulus of rigidity is 80 kN/mm^2 ?
- (a) 63.5 N/mm^2 and 34.6 mm
 (b) 54.2 N/mm^2 and 34.6 mm
 (c) 63.5 N/mm^2 and 42.6 mm
 (d) 54.2 N/mm^2 and 42.6 mm
47. Consider the following statements for a thick-walled cylinder, subjected to an internal pressure :
1. Hoop stress is maximum at the inside radius.
 2. Hoop stress is zero at the outside radius.
 3. Shear stress is maximum at the inside radius.
 4. Radial stress is uniform throughout the thickness of the wall.
- Which of the above statements are correct?
- (a) 1 and 4
 (b) 1 and 3
 (c) 2 and 3
 (d) 2 and 4
48. A helical spring of 10 N/mm rating is mounted on top of another helical spring of 8 N/mm rating. The force required for a total combined deflection of 45 mm through the two springs is
- (a) 100 N
 (b) 150 N
 (c) 200 N
 (d) 250 N
49. In waiting line problems if the arrivals are completely random, then the probability distribution of number of arrivals in a given time follows a/an
- (a) Poisson distribution
 (b) normal distribution
 (c) exponential distribution
 (d) binomial distribution

50. Measured mechanical properties of material are same in a particular direction at each point. This property of the material is known as

- (a) isotropy
- (b) homogeneity
- (c) orthotropy
- (d) anisotropy

51. A long column hinged at both the ends has certain critical Euler's buckling load-carrying capacity. If the same column be fixed at both the ends (in place of hinged ends), the load-carrying capacity then increases to

- (a) 4 times
- (b) 3 times
- (c) 2 times
- (d) Nil

52. The strain energy per unit volume of a round bar under uniaxial tension with axial stress σ and modulus of elasticity E is

- (a) $\frac{\sigma^2}{E}$
- (b) $\frac{\sigma^2}{2E}$
- (c) $\frac{\sigma^2}{3E}$
- (d) $\frac{\sigma^2}{4E}$

53. A steel hub of 100 mm internal diameter and uniform thickness of 10 mm was heated to a temperature of 300 °C to shrink fit it on a shaft. On cooling, a crack developed parallel to the direction of the length of the hub. The cause of the failure is attributable to

- (a) tensile hoop stress
- (b) tensile radial stress
- (c) compressive hoop stress
- (d) compressive radial stress

54. Consider the following statements :

A characteristic of the structure of metallic atoms is that

1. their outermost orbital of electrons is nearly complete and they attract electrons from other atoms
2. their atoms are smaller and more compact than those of non-metallic elements

Which of the above statements is/are correct?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

55. Spark sintering is a kind of hot pressure shaping technique in which

- (a) the arc is produced inside the mould
- (b) the electrical heating of metallic powders by the production of spark in a graphite die is for a short time under pressure
- (c) before passing through the extrusion dies, a constant spark is produced
- (d) None of the above is applicable

56. The capacity of a material to absorb energy when deformed elastically and then to have this energy recovered upon unloading is called

- (a) endurance
- (b) resilience
- (c) toughness
- (d) ductility

57. The recrystallization behaviour of a particular metal alloy is specified in terms of recrystallization temperature, which is typically 1/3rd of the absolute melting temperature of a metal or an alloy and depends on several factors including the amount of

1. cold working and purity of the metal and alloy
2. hot working and purity of the metal and alloy

Which of the above is/are correct?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

58. Consider the following pairs regarding plastics and their respective characteristics :

1. Polycarbonate : Poor impact resistance
2. PTFE : Low coefficient of friction
3. Polypropylene : Excellent fatigue strength

Which of the above pairs is/are correctly matched?

- (a) 1 only
- (b) 2 only
- (c) 1 and 3
- (d) 2 and 3

59. Consider the following statements :

1. Heat treatment is effective only in case of certain alloys.
2. Cooling rate is an important factor in any heat treatment process.
3. The temperature at which the change starts on heating the steel is called lower critical temperature.

Which of the above statements are correct?

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

60. Consider the following processing methods for plastics :

1. Transfer moulding
2. Extrusion
3. Thermoforming
4. Calendering

Which of these are best suited for processing of plastics to their final shape?

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

- 61.** A reaction-bonded silicon nitride ceramic has a strength of 300 MPa and a fracture toughness of $3.6 \text{ MPa} \sqrt{\text{m}}$. With $y = 1$ in the fracture toughness equation, what is the largest size of internal crack that this material can withstand without fracturing?
- (a) 91.6 μm
 (b) 82.3 μm
 (c) 74.6 μm
 (d) 45.8 μm
- 62.** The modulus of elasticity of E-glass is 72 GPa and that of epoxy resin is 3 GPa. The modulus of elasticity (to the nearest unit magnitude) for a composite material consisting of 60% by volume of continuous E-glass fibre and 40% epoxy resin for the matrix, when stressed under isostress conditions, is
- (a) 4 GPa
 (b) 5 GPa
 (c) 6 GPa
 (d) 7 GPa
- 63.** In developing abrasive ceramics which are used to wear, grind or cut away other materials which are (necessarily) softer, they should have, besides wear resistance,
1. a high degree of toughness
 2. a low degree of toughness
 3. refractoriness
- Which of the above is/are correct?
- (a) 1 only
 (b) 2 only
 (c) 1 and 3
 (d) 2 and 3
- 64.** Consider the following in case of high-energy forming processes :
1. The evacuation between die and blank in explosive forming is done by a vacuum pump.
 2. The pressure waves produced in water in explosive forming deform the blank to the die shape.
 3. The electrohydraulic forming makes use of discharge of large amount of electrical energy used in a capacitor bank.
 4. In Petroforge, the piston is moved by combustion of fuel moving at the rate of 150–200 m/s.
- Which of the above are correct?
- (a) 1, 2, 3 and 4
 (b) 1, 2 and 3 only
 (c) 3 and 4 only
 (d) 1, 2 and 4 only
- 65.** In abrasive jet machining process, the main mechanism of material removal takes place due to
- (a) electrochemical action
 (b) mechanical impact
 (c) fatigue failure of the material
 (d) sparking on impact

66. Consider that the following materials are usable for manufacturing dies, moulds in investment casting process for the purpose of large-scale production :

1. Aluminium alloy
2. Magnesium alloy
3. Brass
4. Low-carbon steel

Which of the above are correctly usable?

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

67. The occurrence of casting defect 'rat tail' is possible because of

1. soft ramming of sand
2. continuous large flat surface on the mould
3. excessive hardness of the mould

Which of the above reasons are correct?

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

68. Components produced by die casting have finer grain, higher strength and greater hardness at the skin than at the centre due to

- (a) decreased wall thickness of die cavity
- (b) rapid chilling of molten metal at the die walls
- (c) high temperature involved in the process
- (d) high tonnage of die casting machines

69. A 125 mm long, 10 mm diameter stainless steel rod is being turned to 9 mm diameter, 0.5 mm depth of cut. The spindle rotates at 360 r.p.m. With the tool traversing at an axial speed of 175 mm/min, the metal removal rate is nearly

- (a) 2200 mm³/min
- (b) 2400 mm³/min
- (c) 2600 mm³/min
- (d) 2800 mm³/min

70. The feed in face milling for a width of 70 mm with a cutter of 160 mm diameter, having 10 inserts and rotating at 360 r.p.m., with a feed rate of 0.5 m/min, is nearly

- (a) 0.21 mm/tooth
- (b) 0.18 mm/tooth
- (c) 0.14 mm/tooth
- (d) 0.11 mm/tooth

71. A lathe consumes 500 W when running idle and 2500 W when cutting a steel specimen at 30 m/min. If the depth of cut is 4 mm and feed rate is 0.25 mm/rev, the cutting force and the approximate value of torque at a spindle run of 120 r.p.m. will respectively be

- (a) 4000 N and 160 N-m
- (b) 3000 N and 160 N-m
- (c) 4000 N and 100 N-m
- (d) 3000 N and 100 N-m

72. For a shaper, the length of stroke is 210 mm, the number of double strokes per minute is 32 and the ratio of return time to cutting time is 2 : 3. The cutting speed will be

- (a) 8.1 m/min
- (b) 11.2 m/min
- (c) 14.3 m/min
- (d) 17.4 m/min

73. The headstock of a lathe has 9 speeds with minimum speed of 100 r.p.m. and maximum speed of 1600 r.p.m. If the speeds are in geometric progression, then the ratio is

- (a) 1.06
- (b) 1.22
- (c) 1.41
- (d) 1.64

74. Surface cracking occurring at low temperatures in hydrostatic extrusion is known as

- (a) fluid defect
- (b) bamboo defect
- (c) fishtailing
- (d) arrowhead fracture

75. Flank wear occurs mainly on the

1. nose part of the cutting tool
2. front relief face and side relief face of the cutting tool
3. face of the cutting tool at the shortest distance from the cutting edge

Which of the above is/are correct?

- (a) 1 and 2
- (b) 1 and 3
- (c) 2 only
- (d) 1 only

76. A part programme for any arbitrary object is given as follows :

```
N001 G91 G71 M03 S600 EOB
N002 G00 X 10.00 Y10.00 EOB
N003 G00 Z-10.00 EOB
N004 G83 Z-60.00 F100 EOB
N005 G80 EOB
N006 M02 EOB
```

The above programming format will be used as Canned cycle for

- (a) drilling
- (b) tapping
- (c) boring
- (d) grooving

77. In case of TIG welding of aluminium alloys, the amount of shielding gas used can be determined from the band of white deposit (aluminium oxide) alongside of the weld bead. A hairline width white band indicates that the quantum of shielding gas used has been

1. more than required
2. lesser than required
3. adequate as required

Which of the above is correct?

- (a) 1
- (b) 2
- (c) 3
- (d) Cannot be determined due to insufficient information

78. If H is the heat input, l is the weld length, V is the voltage applied, I is the current, v is the welding speed and e is the efficiency of the process, then the process-governing equation in arc welding is given by

(a) $\frac{H}{l} = e \frac{VI}{v}$

(b) $\frac{H}{v} = e \frac{VI}{l}$

(c) $H = e \frac{VI}{vl}$

(d) $H = eVI \cdot vl$

79. A Cylindrical Robot can reach any point in a cylinder of height L and radius $2L$, except for the points in an inner cylinder of height L and radius L . The volume for the Cylindrical Robot work envelope will be

(a) $9.42L^3$

(b) $6.24L^3$

(c) $9.12L^3$

(d) $9.86L^3$

80. Consider the following statements about forging :

1. Forgings have high strength and ductility.
2. Forgings offer great resistance to impact and fatigue loads.
3. Forging assures uniformity in density as well as dimensions of the forged parts.

Which of the above statements are correct?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

81. In a machining test, a cutting speed of 100 m/min indicated the tool life as 16 min and a cutting speed of 200 m/min indicated the tool life as 4 min. The values of n and C are

(a) 0.5 and 200

(b) 0.25 and 200

(c) 0.5 and 400

(d) 0.25 and 400

82. Which of the following Robots has application for mobile platform handling in cockpit flight simulators?

(a) SCARA Robot

(b) Articulated Robot

(c) Parallel Robot

(d) Cylindrical Robot

83. What is the degree of operating leverage in the following cases?

1. Where profit is ₹ 5,00,000 and total fixed cost is ₹ 4,00,000

2. Where 1% increase in output brings in 3% increase in profit

(a) 0.8 and 3

(b) 1.5 and 3

(c) 0.8 and 4

(d) 1.5 and 4

84. The input variables of EDM under a given combination of electrode (tool), dielectric and workpiece are

(a) surface finish and metal removal rate

(b) frequency of current and surface finish

(c) amperage and frequency

(d) metal removal rate and amperage

85. During the formation of chips in machining with a cutting tool, which one of the following relations holds good?

(a) $\frac{V}{\cos(\phi - \alpha)} = \frac{V_S}{\cos\alpha} = \frac{V_C}{\sin\alpha}$

(b) $\frac{V}{\sin(\phi - \alpha)} = \frac{V_S}{\cos\alpha} = \frac{V_C}{\cos\alpha}$

(c) $\frac{V}{\cos\alpha} = \frac{V_C}{\sin\alpha} = \frac{V_S}{\sin(\phi - \alpha)}$

(d) $V\cos\alpha = V_C \sin\alpha = V_S \cos(\alpha - \phi)$

where V is the cutting speed, V_C is the velocity of the chip, V_S is the velocity at which shearing takes place along the shear plane, ϕ is the shear angle and α is the rake angle.

86. The complexity of a jig or a fixture is determined by

1. the number of pieces that must be produced
2. the degree of accuracy required
3. the number and kind of machining operations that must be performed

Which of the above are correct?

- (a) 1 and 2 only
 (b) 1 and 3 only
 (c) 2 and 3 only
 (d) 1, 2 and 3

87. For a small-scale industry, the fixed cost per month is ₹ 5,000. The variable cost per product is ₹ 20 and the sales price is ₹ 30 per piece. The break-even production per month will be

- (a) 300
 (b) 400
 (c) 500
 (d) 600

88. Coriolis component of acceleration depends on

1. angular velocity of the link
2. acceleration of the slider
3. angular acceleration of the link

Which of the above is/are correct?

- (a) 1 only
 (b) 2 only
 (c) 1 and 3
 (d) 2 and 3

89. Which one of the following distributions provides information regarding the uncertainty of duration time estimates in PERT described network?

- (a) Beta-distribution
 (b) Normal distribution
 (c) Poisson distribution
 (d) Binomial distribution

90. When an ordering cost is increased to 4 times, the EOQ will be increased to

- (a) 2 times
 (b) 4 times
 (c) 8 times
 (d) 16 times

91. The weekly sale for an item is A units. The ordering cost per order is B rupees. The carrying cost per unit per month is C rupees. The EOQ (with a year of 52 weeks as the basis) will nearly be

- (a) $\sqrt{\frac{8 \cdot 7A}{BC}}$
 (b) $\sqrt{\frac{8 \cdot 7AB}{C}}$
 (c) $\sqrt{\frac{4 \cdot 35A}{BC}}$
 (d) $\sqrt{\frac{4 \cdot 35AB}{C}}$

92. A self-service store employs one cashier at its counter. 8 customers arrive on an average every 5 minutes, whereas cashier can serve 10 customers in same time. Assuming Poisson distribution for service rate, the average time a customer spends in the queue will be

- (a) 4 minutes
 (b) 3 minutes
 (c) 2 minutes
 (d) 1 minute

93. In an internally pressurized thick cylinder, the hoop stress

1. remains constant but the radial stress varies parabolically
2. varies parabolically but the radial stress remains constant

Which of the above is/are correct?

- (a) 1 only
 (b) 2 only
 (c) Both 1 and 2
 (d) Neither 1 nor 2

94. Consider the following statements for down-milling operation :

1. The workpiece is forced against the holding device by the cutter.
2. The cutting tool rotates in the same direction.
3. Backlash elimination is not required.
4. The cut starts with a full chip thickness.

Which of the above statements are correct in this context?

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

95. Consider the following functions regarding production control department :

1. Provision of resources
2. Preparation of production schedules
3. To maintain the requisite quality standards

Which of the above functions are correct?

- (a) 1 and 2 only
 (b) 1 and 3 only
 (c) 2 and 3 only
 (d) 1, 2 and 3

96. Auditing of the measurement systems establishes

1. whether they are informing enough for decision making
2. whether the cost of data collection is merited
3. whether measurements are being taking accurately

Which of the above are correct?

- (a) 1 and 2 only
- (b) 1 and 3 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

97. Consider the following statements with respect to flow diagram in work study :

1. Movement of machines is drawn in flow diagram.
2. Movement of men is drawn in flow diagram.
3. In flow diagram, all movements are drawn true to scale.

Which of the above statements are correct?

- (a) 1 and 2 only
- (b) 1 and 3 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

98. An organization uses ABC approach for categorization of its stock. Which of the following describe class C items?

- (a) High value and high risk
- (b) High value and low risk
- (c) Low value and high risk
- (d) Low value and low risk

99. Consider the following elements of situation awareness :

1. Perception of elements in the environment within a volume of time and space, comprehension of their meaning and projection of their status in the future
2. Perception of elements in the environment within a volume of time and space, comprehension of their meaning, projection of their status in the future and interpretation of the results
3. Sensing of the elements in the environment, perception of those elements, analysis of consequences, projection of alternative outcomes and interpretation of the results

Which of the above is/are correct?

- (a) 1 only
- (b) 1 and 2
- (c) 2 and 3
- (d) 3 only

100. In case of design of friction clutches, uniform rate of wear theory is used over uniform pressure. The reasons may be the following :

1. It gives higher frictional torque.
2. It gives lower frictional torque.
3. The intensity of pressure is maximum at the inner radius and minimum at the outer radius of the friction or contact surfaces.
4. This concept is prevalent for running and old clutches.

Which of the above reasons are correct?

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

Directions :

Each of the following **twenty (20)** items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the code given below.

Code :

- (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 but 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

101. Statement (I) :

Automated guided vehicle (AGV) is a programmable mobile vehicle without human intervention and used for material handling.

Statement (II) :

Automated storage and retrieval system (AS/RS) is a part of CNC machine and used for machining operation.

102. Statement (I) :

The follower motion represented on the displacement diagram is achieved by proper cam profile.

Statement (II) :

The cam profile is constructed using the principle of kinematic inversion.

103. Statement (I) :

Composite material is combination of two or more chemically unlike materials.

Statement (II) :

Composite materials have their own specific properties and are different from their individual material properties.

104. Statement (I) :

The epicyclic gear train has a central gear and an epicyclic gear which produces epicyclic motion being moved by a crank arm.

Statement (II) :

The arm contains the bearings for the epicyclic gear to maintain two gears in mesh.

105. Statement (I) :

Two non-intersecting and non-parallel, i.e., non-coplanar, shafts connected by gears are called skew-bevel gears or spiral gears, and this type of gearing has a line contact the rotation of which about the axes generates the two hyperboloid pitch surfaces.

Statement (II) :

A hyperboloid is a 3D surface formed by revolving a straight line about an axis (not in the same plane), such that every point on the line remains at a constant distance from the axis.

106. Statement (I) :

Motor vehicles have differential gear mechanism at the back axle.

Statement (II) :

This mechanism is fitted to enable the vehicles to run on bumpy roads.

107. Statement (I) :

The distribution of mass along the axis of rotation of a shaft depends on the configuration of the part.

Statement (II) :

All mass centres must fall on straight line parallel to the axis of the shaft for complete dynamic balancing.

108. Statement (I) :

In resistance welding of sheet metal, filler rod is not used.

Statement (II) :

It is the filler rod which gets oxidized and deposits the oxide in the weldment.

109. Statement (I) :

The linear speed of the belt in a belt drive is controlled by the tensile strength of the material of the driven pulley (larger in diameter).

Statement (II) :

The rotating pulley rim is subjected to tensile hoop stress.

110. Statement (I) :

In an epicyclic gear train, the size of the gearbox is smaller than that of the spur gearbox for the same horsepower and the same velocity ratio.

Statement (II) :

In an epicyclic gearbox, more than one pair of gear pinion contacts always exist, whereas it is not so in spur gearbox.

111. Statement (I) :

Pursuant to plastic deformation of metals, the mechanical properties of the metals get changed.

Statement (II) :

Mechanical properties of metals depend on grain size also which gets changed by plastic deformation.

112. Statement (I) :

In quick return motion mechanism, Coriolis acceleration exists.

Statement (II) :

Two links in this mechanism oscillate with one sliding relative to the other.

113. Statement (I) :

Ceramics withstand very high temperatures that range from 1000 °C to 1600 °C.

Statement (II) :

Silicon carbide is an exception from among ceramics that can withstand high temperatures.

114. Statement (I) :

Employing the extrusion process is not economical in case of large billets.

Statement (II) :

A significant part of the press capacity is lost overcoming frictional resistance between workpiece and cylinder wall during the extrusion process.

115. Statement (I) :

In drop forging, the excess metal added to the stock for complete filling of the die cavity is called flash.

Statement (II) :

Flash acts as a cushion against impact blows attributable to the finishing impression.

116. Statement (I) :

In wire-drawing, the end of the stock is made 'pointed' to make for easier entrance of the wire into the die.

Statement (II) :

The pointing of the wire is done exclusively by rotary swaging and not by simple hammering.

117. Statement (I) :

Metal powders can be produced by atomization process.

Statement (II) :

In case of metals with low melting point, the size of particles cannot be controlled and the shape of the particles remains regular in atomization.

118. Statement (I) :

In shell moulding process, phenol formaldehyde is never used.

Statement (II) :

The resins used in this process are basically of the thermoplastic variety.

119. Statement (I) :

Both sand and metal moulds can be used for centrifugal casting.

Statement (II) :

In this process, sand moulds are recommended when chilling tendency is to be prevented.

120. Statement (I) :

In gas welding process, neutral flame is the most common flame used for welding and cutting stainless steel.

Statement (II) :

Neutral flame has tendency to react with stainless steel being welded.

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