# OPSC
# MVI

## Previous Year Paper
## (Mechanical Engg.)
## 05 May, 2024

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Test Booklet Series

T. B. C. : MVI-II-23/24

# TEST BOOKLET

**A**

**INSPECTOR OF MOTOR VEHICLE/ADDITIONAL R.T.O. (ENFORCEMENT)/ASSISTANT WORKS ENGINEER**

**( MECHANICAL ENGINEERING )** Sl. No. **20817**

**Time Allowed : 3 Hours** | **Maximum Marks : 150**

## : INSTRUCTIONS TO CANDIDATES :

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 OF THE SAME SERIES ISSUED TO YOU.
2. ENCODE CLEARLY THE TEST BOOKLET SERIES **A, B, C** OR **D**, AS THE CASE MAY BE, IN THE APPROPRIATE PLACE IN THE ANSWER SHEET USING BALL POINT PEN (BLUE OR BLACK).
3. You have to enter your **Roll No.** on the Test Booklet in the Box provided alongside. **DO NOT** write *anything else* on the Test Booklet.
4. **YOU ARE REQUIRED TO FILL UP & DARKEN ROLL NO., TEST BOOKLET / QUESTION BOOKLET SERIES IN THE ANSWER SHEET AS WELL AS FILL UP TEST BOOKLET / QUESTION BOOKLET SERIES AND SERIAL NO. AND ANSWER SHEET SERIAL NO. IN THE ATTENDANCE SHEET CAREFULLY. WRONGLY FILLED UP ANSWER SHEETS ARE LIABLE FOR REJECTION AT THE RISK OF THE CANDIDATE.**
5. This Test Booklet contains **150** items (questions). Each item (question) comprises of four responses (answers). You have to select the correct response (answer) which you want to mark (darken) on the Answer Sheet. In case, you feel that there is more than one correct response (answer), you should mark (darken) the response (answer) which you consider the best. In any case, choose **ONLY ONE** response (answer) for each item (question).
6. You have to mark (darken) all your responses (answers) **ONLY** on the **separate Answer Sheet** provided, by **using BALL POINT PEN (BLUE OR BLACK)**. See instructions in the Answer Sheet.
7. All items (questions) carry equal marks. All items (questions) are compulsory. Your total marks will depend only on the number of correct responses (answers) marked by you in the Answer Sheet. **There shall be negative marking at the rate of 25% assigned to a correct answer for each wrong response.**
8. Before you proceed to mark (darken) in the Answer Sheet the responses (answers) to various items (questions) in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per the instructions sent to you with your **Admission Certificate**.
9. After you have completed filling in all your responses (answers) on the Answer Sheet and after conclusion of the examination, you should hand over to the Invigilator the *Answer Sheet* issued to you. You are allowed to take with you the candidate's copy / second page of the Answer Sheet along with the **Test Booklet**, after completion of the examination, for your reference.
10. Sheets for rough work are appended in the Test Booklet at the end.

SEAL

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1. Which one of the following statements is ***correct***?

(A) Energy and work are scalars

(B) Force and work are vectors

(C) Energy, momentum and velocity are vectors

(D) Force, momentum and velocity are scalars

2. Consider the following statements :

*(i)* Two couples in the same plane can be added algebraically.

*(ii)* Coplanar and concurrent forces are the ones that neither lie in one plane nor meet at a point.

*(iii)* Non-concurrent forces are the ones that do not meet at a point.

*(iv)* A single force may be replaced by a force and a couple.

Which of the above statements are ***correct***?

(A) *(i)*, *(ii)* and *(iv)*

(B) *(ii)*, *(iii)* and *(iv)*

(C) *(i)*, *(ii)* and *(iii)*

(D) *(i)*, *(iii)* and *(iv)*

3. The reaction (in kN) at the support *A* for the beam shown in Fig. is

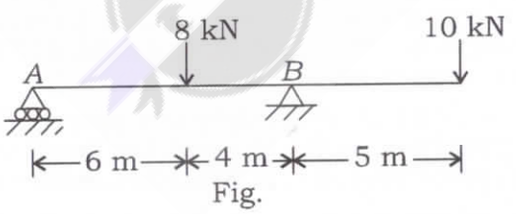

Fig.

(A) 18

(B) 0·8

(C) 1·8

(D) None of the above

4. Fig. shows the loading pattern on a truss. The force in the member *AC* is

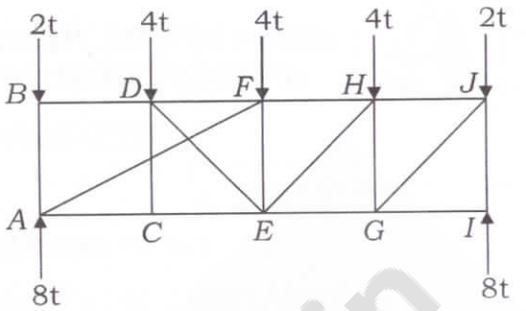

Fig.

(A) zero

(B) 2t

(C) 8t

(D) statically indeterminate

5. The block shown in Fig. is kept in equilibrium and prevented from sliding down by applying a force of 500 N. The coefficient of friction is $\sqrt{3}/5$. The weight of the block would be

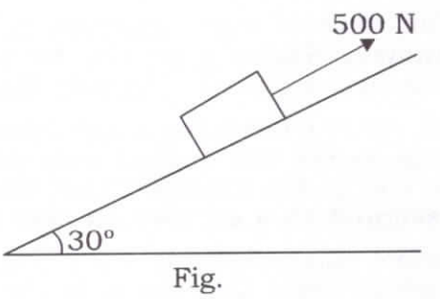

Fig.

(A) 4000 N

(B) 2500 N

(C) 1000 N

(D) 500 N

6. The motion of a particle (distance in meters and time in seconds) is given by the equation $s = 2t^3 + 3t$. Starting from $t = 0$, to attain a velocity of 9 m/s, the article will have to travel a distance of

(A) 5 m

(B) 10 m

(C) 15 m

(D) 20 m

7. In Fig., two bodies of masses $m_1$ and $m_2$ are connected by a light inextensible string passing over a smooth pulley. Mass $m_2$ lies on a smooth horizontal plane. When mass $m_1$ moves downwards, the acceleration of the two bodies is equal to

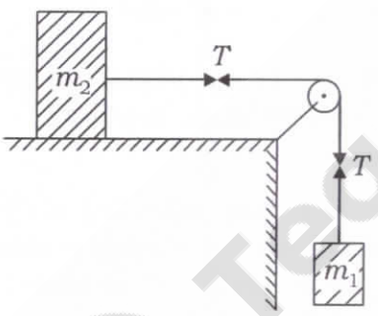


Fig.

(A) $\frac{m_1 g}{m_1 + m_2}$ m/s$^2$

(B) $\frac{m_2 g}{m_1 - m_2}$ m/s$^2$

(C) $\frac{m_2 g}{m_1 + m_2}$ m/s$^2$

(D) $\frac{m_1 g}{m_1 - m_2}$ m/s$^2$

8. A person, carrying on his head a jewellery box of weight $W$, jumped down from the third storey of a building. Before touching the ground, he would feel a load of magnitude

(A) zero

(B) $W/2$

(C) $W$

(D) infinity

9. A cord is wrapped around a cylinder of radius $r$ and mass $m$ as shown in Fig. If the cylinder is released from rest, the velocity of the cylinder, after it has moved through a distance $h$, will be

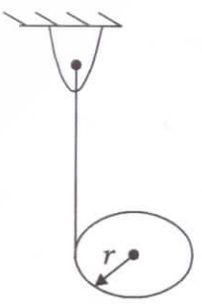


Fig.

(A) $\sqrt{2gh}$

(B) $\sqrt{gh}$

(C) $\sqrt{4gh}/3$

(D) $\sqrt{gh/3}$

10. What is the work done, if a bucket of water weighing 10 N is pulled up from a well 20 m deep by a rope weighing 1 N/m?

(A) 200 Nm

(B) 400 Nm

(C) 500 Nm

(D) 600 Nm

**11.** Two masses, 2 kg and 8 kg are moving with equal kinetic energy. The ratio of magnitudes of their momentum is

(A) 0·25

(B) 0·50

(C) 0·625

(D) 1·00

**12.** 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 $E = 200$ GPa, the elongation of the bar will be

(A) 1·25 mm

(B) 2·70 mm

(C) 4·05 mm

(D) 5·40 mm

**13.** The ultimate tensile strength of a material is 400 MPa and the elongation up to the maximum load is 35%. If the material obeys the power law of hardening, then the true stress-true strain relation (stress in MPa) in the plastic deformation range is

(A) $\sigma = 540\,\varepsilon^{0.3}$

(B) $\sigma = 775\,\varepsilon^{0.3}$

(C) $\sigma = 540\,\varepsilon^{0.35}$

(D) $\sigma = 775\,\varepsilon^{0.35}$

**14.** A test specimen is stressed slightly beyond the yield point and then unloaded. Its yield strength will

(A) decrease

(B) increase

(C) remain same

(D) become equal to ultimate tensile strength

**15.** A bar of length $L$ tapers uniformly from diameter $1{\cdot}1\,D$ at one end to $0{\cdot}9\,D$ at the other end. The elongation due to axial pull is computed using mean diameter $D$. What is the approximate error in computed elongation?

(A) 10%

(B) 5%

(C) 1%

(D) 0·5%

**16.** If the value of Poisson's ratio is zero, then it means that

(A) the material is rigid

(B) the material is perfectly plastic

(C) there is no longitudinal strain in the material

(D) the longitudinal strain in the material is infinite

**17.** Consider the following statements : To increase the fatigue strength of welded joints, it is necessary to employ

*(i)* grinding

*(ii)* coating

*(iii)* hammer peening

Choose the ***correct*** answer.

(A) *(i)* and *(ii)* are correct

(B) *(ii)* and *(iii)* are correct

(C) *(i)* and *(iii)* are correct

(D) *(i)*, *(ii)* and *(iii)* are correct

**18.** The Fig. below shows a steel rod of 25 $mm^2$ cross-sectional area. It is loaded at four points $K$, $L$, $M$ and $N$. Assume $E_{steel} = 200\,GPa$. The total change in length of the rod due to loading is

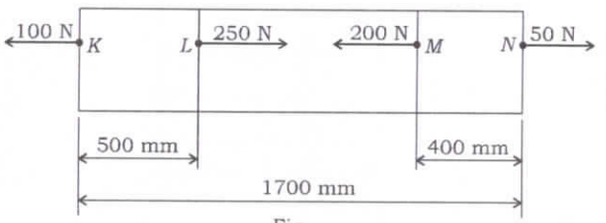

Fig.

(A) 1 μm

(B) −10 μm

(C) 16 μm

(D) −20 μm

**19.** The Mohr's circle of plane stress for a point in a body is shown in Fig. The design is to be done on the basis of the maximum shear stress theory for yielding. Then, yielding will just begin if the designer chooses a ductile material whose yield strength is

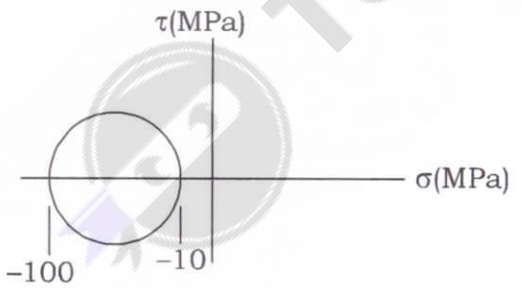

Fig.

(A) 45 MPa

(B) 50 MPa

(C) 90 MPa

(D) 100 MPa

**20.** Match **List—I** with **List—II** and select the ***correct*** answer using the code given below the lists :

| **List—I ( Condition of beam )** | **List—II ( Bending moment diagram )** |
|---|---|
| *(a)* Subjected to bending moment at the end of a cantilever | *(i)* Triangle |
| *(b)* Cantilever carrying uniformly distributed load over the whole length | *(ii)* Cubic parabola |
| *(c)* Cantilever carrying linearly varying load from zero at the fixed end to maximum at the support | *(iii)* Parabola |
| *(d)* A beam having load at the centre and supported at the ends | *(iv)* Rectangle |

***Code :***

(A) *(a)–(iv), (b)–(i), (c)–(ii), (d)–(iii)*

(B) *(a)–(iv), (b)–(iii), (c)–(ii), (d)–(i)*

(C) *(a)–(iii), (b)–(iv), (c)–(ii), (d)–(i)*

(D) *(a)–(iii), (b)–(iv), (c)–(i), (d)–(ii)*

**21.** A uniformly distributed load $w$ (in kN/m) is acting over the entire length of a 3 m long cantilever beam. If the shear force at the midpoint of cantilever is 6 kN, what is the value of $w$?

(A) 2

(B) 3

(C) 4

(D) 5

**22.** A small element at the critical section of a component is in a bi-axial state of stress with the two principal stresses being 360 MPa and 140 MPa. The maximum working stress according to Distortion Energy Theory is

(A) 220 MPa

(B) 110 MPa

(C) 314 MPa

(D) 330 MPa

**23.** What is the expression for the strain energy due to bending of a cantilever beam (length $L$, modulus of elasticity $E$ and moment of inertia $I$)?

(A) $\frac{P^2L^3}{3EI}$

(B) $\frac{P^2L^3}{6EI}$

(C) $\frac{P^2L^3}{4EI}$

(D) $\frac{P^2L^3}{48EI}$

**24.** For the component loaded with a force $F$ as shown in the Fig., the axial stress at the corner point $P$ is

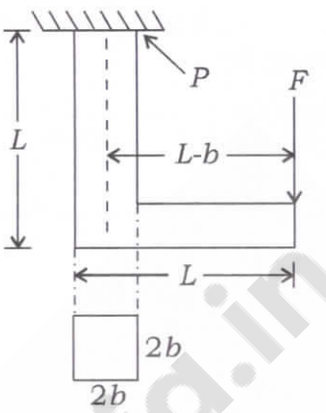

Fig.

(A) $\frac{F(3L-b)}{4b^3}$

(B) $\frac{F(3L+b)}{4b^3}$

(C) $\frac{F(3L-4b)}{4b^3}$

(D) $\frac{F(3L-2b)}{4b^3}$

**25.** A bar of length $L$ and uniform cross-section with area $A$ is subjected to both tensile force $P$ and torque $T$. If $G$ is the shear modulus and $E$ is the Young's modulus, the internal strain energy stored in the bar is

(A) $\frac{T^2L}{2GJ}+\frac{P^2L}{AE}$

(B) $\frac{T^2L}{GJ}+\frac{P^2L}{2AE}$

(C) $\frac{T^2L}{2GJ}+\frac{P^2L}{2AE}$

(D) $\frac{T^2L}{GJ}+\frac{P^2L}{AE}$

**26.** A 60 mm long and 6 mm thick fillet weld carries a steady load of 15 kN along the weld. The shear strength of the weld material is equal to 200 MPa. The factor of safety is

(A) 2·4

(B) 3·4

(C) 4·8

(D) 6·8

**27.** A threaded nut of M16, ISO metric type, having 2 mm pitch with a pitch diameter of 14·701 mm is to be checked for its pitch diameter using two or three numbers of balls or rollers of which of the following sizes?

(A) Roller of 2 mm $\phi$

(B) Roller of 1·155 mm $\phi$

(C) Ball of 2 mm $\phi$

(D) Ball of 1·155 mm $\phi$

**28.** Match the following :

| **( Types of Gears )** | **( Arrangement of shafts )** |
|---|---|
| *P.* Bevel gears | *(i)* Non-parallel offset shafts |
| *Q.* Worm gears | *(ii)* Non-parallel intersecting shafts |
| *R.* Herring-bone gears | *(iii)* Non-parallel non-intersecting shafts |
| *S.* Hypoid gears | *(iv)* Parallel shafts |

***Code*** :

(A) *P–(iv), Q–(ii), R–(i), S–(iii)*

(B) *P–(ii), Q–(iii), R–(iv), S–(i)*

(C) *P–(iii), Q–(ii), R–(i), S–(iv)*

(D) *P–(i), Q–(iii), R–(iv), S–(ii)*

**29.** 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 mPa-s. The radial clearance is 50 μm. The Sommerfeld number for the bearing is

(A) 0·062

(B) 0·125

(C) 0·250

(D) 0·785

**30.** What is sunk key made in the form of a segment of a circular disc of uniform thickness known as?

(A) Feather key

(B) Kennedy key

(C) Woodruff key

(D) Saddle key

**31.** A flywheel has a mass of 300 kg and a radius of gyration of 1 m. It is given a spin of 100 rpm about its horizontal axis. The whole assembly rotates about a vertical axis at 6 rad/sec. The gyroscopic couple experienced will be

(A) 3π kNm

(B) 6π kNm

(C) 180π kNm

(D) 360π kNm

**32.** A block-brake shown in Fig. has a face width of 300 mm and a mean coefficient of 0·25. For an activating force of 400 N, the breaking torque in Nm is

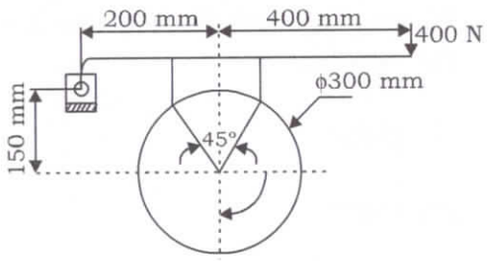

Fig.

(A) 30

(B) 40

(C) 45

(D) 60

**33.** Match **List—I** with **List—II** and select the correct answer using the code given below the lists :

| **List—I ( Material properties )** | **List—II ( Tests to determine material properties )** |
|---|---|
| *(a)* Ductility | *(i)* Impact test |
| *(b)* Toughness | *(ii)* Fatigue test |
| *(c)* Endurance limit | *(iii)* Tension test |
| *(d)* Resistance to penetration | *(iv)* Hardness test |

***Code :***

(A) *(a)–(iii), (b)–(ii), (c)–(i), (d)–(iv)*

(B) *(a)–(iv), (b)–(ii), (c)–(i), (d)–(iii)*

(C) *(a)–(iii), (b)–(i), (c)–(ii), (d)–(iv)*

(D) *(a)–(iv), (b)–(i), (c)–(ii), (d)–(iii)*

**34.** In terms of theoretical stress concentration factor ($K_t$) and fatigue stress concentration factor ($K_f$), notch sensitivity $q$ is expressed as

(A) $(K_f - 1)/(K_t - 1)$

(B) $(K_f - 1)/(K_t + 1)$

(C) $(K_t - 1)/(K_f - 1)$

(D) $(K_t + 1)/(K_f + 1)$

**35.** Given that $T_1$ and $T_2$ are the tensions on the tight and slack sides of the belt respectively, the initial tension of the belt taking into account centrifugal tension $T_c$, is equal to

(A) $\frac{T_1 + T_2 + T_c}{3}$

(B) $\frac{T_1 + T_2 + 2T_c}{2}$

(C) $\frac{T_1 + T_2 + 3T_c}{3}$

(D) $\frac{T_1 - T_2 + 3T_c}{3}$

**36.** When the intensity of pressure is uniform in a flat pivot bearing of radius $r$, the friction force is assumed to act at

(A) $r$

(B) $r/2$

(C) $2r/3$

(D) $r/3$

**37.** In a kinematic chain, a quaternary joint is equivalent to

(A) one binary joint

(B) two binary joints

(C) three binary joints

(D) four binary joints

**38.** In a four-link kinematic chain, the relation between the number of links ($L$) and number of pairs ($j$) is

(A) $L = 2j + 4$

(B) $L = 2j - 4$

(C) $L = 4j + 2$

(D) $L = 4j - 2$

**39.** The number of degrees of freedom of a five-link plane mechanism with five revolute pairs as shown in Fig. is

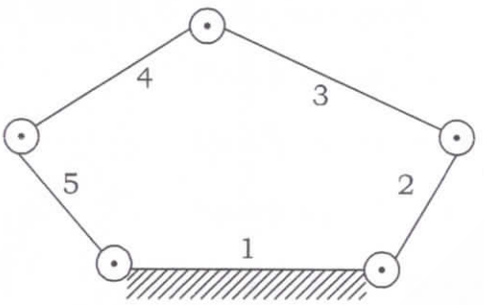


Fig.

(A) 3

(B) 4

(C) 2

(D) 1

**40.** What is the value of the radius of gyration of disc type flywheel as compared to rim type flywheel for the same diameter?

(A) $\sqrt{2}$ times

(B) $1/\sqrt{2}$ times

(C) 2 times

(D) 1/2 times

**41.** The amount of energy absorbed by a flywheel is determined from the

(A) torque-crank angle diagram

(B) acceleration-crank angle diagram

(C) speed-space diagram

(D) speed-energy diagram

**42.** The shaft-rotor system shown in Fig. is

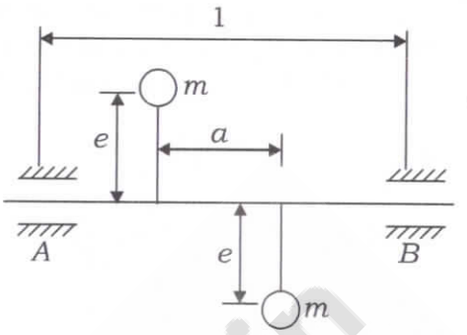


Fig.

(A) statically balanced only

(B) dynamically balanced only

(C) both statically and dynamically balanced

(D) neither statically nor dynamically balanced

**43.** For $L$ number of links in a mechanism, the number of possible inversions is equal to

(A) $L - 2$

(B) $L - 1$

(C) $L$

(D) $L + 1$

**44.** The equation of free vibrations of a system is $\ddot{x} + 36\pi^2 x = 0$. Its natural frequency is

(A) 6 Hz

(B) $3\pi$ Hz

(C) 3 Hz

(D) $6\pi$ Hz

**45.** The height $h$ of Porter governor with equal arms pivoted at equal distance from axis of rotation is expressed as (where $m$ = mass of balls of the governor, $M$ = mass of sleeve of the governor and $N$ = rpm

(A) $h = 91{\cdot}2\left[\frac{m+M}{m}\right]\frac{g}{N^2}$

(B) $h = 91{\cdot}2\left[\frac{mg+Mg}{m}\right]\frac{g}{N^2}$

(C) $h = 91{\cdot}2\left[\frac{m}{mM}\right]\frac{g}{N^2}$

(D) $h = 91{\cdot}2\left[\frac{M}{m}\right]\frac{g}{N^2}$

**46.** The profile of a cam in a particular zone is given by $x = \sqrt{3}\cos\theta$ and $y = \sin\theta$. The normal to the cam profile at $\theta = \pi/4$ is at an angle (with respect to $x$ axis)

(A) $\pi/4$

(B) $\pi/2$

(C) $\pi/3$

(D) 0

**47.** Minimum shear strain in orthogonal turning with a cutting tool of zero rake angle is

(A) 0

(B) 0·5

(C) 1·0

(D) 2·0

**48.** Cold working of steel is defined as working

(A) at its recrystallisation temperature

(B) above its recrystallisation temperature

(C) below its recrystallisation temperature

(D) at two-third of the melting temperature of the metal

**49.** In a typical metal cutting operation, using a cutting tool of positive rake angle = 10°, it was observed that the shear angle was 20°. The friction angle is

(A) 45°

(B) 30°

(C) 60°

(D) 40°

**50.** The relationship between the shear angle $\phi$, the friction angle $\beta$ and cutting rake angle $\alpha$ is given as

(A) $2\beta + \phi - \alpha = \pi/4$

(B) $2\phi + \beta - \alpha = \pi/2$

(C) $2\alpha + \beta - \phi = \pi/4$

(D) $2\alpha + \beta - \phi = \frac{\pi}{2}$

**51.** The relation between the tool life ($T$) in minutes and cutting speed ($V$) in m/min is

(A) $V^nT = C$

(B) $VT^n = C$

(C) $V^n/T = C$

(D) $V/T^n = C$

**52.** Using the Taylor equation for tool life and letting $n = 0{\cdot}5$ and $C = 400$, calculate the percentage increase in tool life when the cutting speed is reduced by 50%.

(A) 100%

(B) 200%

(C) 300%

(D) 400%

**53.** Flank wear occurs mainly on the

(A) nose part, front relief face and side relief face of the cutting tool

(B) face of the cutting tool at a short distance from the cutting edge only

(C) cutting edge only

(D) front face only

**54.** A shaft and hole pair is designated as 50 H7d8. The assembly constitutes

(A) interference fit

(B) transition fit

(C) clearance fit

(D) None of the above

**55.** Which of the following is an interference fit?

(A) Push fit

(B) Running fit

(C) Sliding fit

(D) Shrink fit

**56.** Dimension of the hole is $50^{+0\cdot02}_{-0\cdot00}$ mm and shaft is $50^{+0\cdot02}_{+0\cdot00}$ mm. The minimum clearance is

(A) 0·02 mm

(B) 0·00 mm

(C) – 0·02 mm

(D) 0·01 mm

**57.** Which one of the following forecasting techniques is ***not*** suited for making forecasts for planning production schedules in the short range?

(A) Moving average

(B) Exponential moving average

(C) Regression analysis

(D) Delphi

**58.** The sales of a product during the last four years were 860, 880, 870 and 890 units respectively. The forecast for the fourth year was 876 units. If the forecast for the fifth year, using simple exponential smoothing, is equal to the forecast using a three-period moving average, the value of the exponential smoothing constant 'a' is

(A) 1/7

(B) 1/5

(C) 2/7

(D) 1/3

**59.** Four jobs are to be processed on a machine as per data listed in the table :

| Job | Processing time (in days) | Due date |
|---|---|---|
| 1 | 4 | 6 |
| 2 | 7 | 9 |
| 3 | 2 | 19 |
| 4 | 8 | 17 |

If the Earliest Due Date (EDD) rule is used to sequence the jobs, the number of jobs delayed is

(A) 1

(B) 2

(C) 3

(D) 4

**60.** For the data given in question no. 59, what is the total tardiness using Shortest Processing Time (SPT) rule?

(A) 0

(B) 2

(C) 6

(D) 8

**61.** The following activities are to be performed in a particular sequence for routing a product :

*(i)* Analysis of the product and breaking it down into components

*(ii)* Determination of the Lot size

*(iii)* Determination of operations and processing time requirement

*(iv)* Taking make or buy decisions

The ***correct*** sequence of these activities is

(A) *(i), (ii), (iii), (iv)*

(B) *(iii), (i), (ii), (iv)*

(C) *(iii), (i), (iv), (ii)*

(D) *(i), (iv), (iii), (ii)*

**62.** A company has four work centres A, B, C and D with per day capacities of 450 units, 390 units, 360 units and 400 units respectively. The machines are laid down in order A, B, C and D and product has to be operated on all these machines for getting converted into finished product. The actual output turns out to be 306 units per day. What is the system efficiency?

(A) 68%

(B) 78%

(C) 80%

(D) 85%

**63.** In an assembly line, when the workstation times are unequal, the overall production rate of an assembly line is determined by the

(A) fastest station time

(B) slowest station time

(C) average of all station times

(D) average of slowest and fastest station times

**64.** Last year, a manufacturer produced 15000 products which were sold for ₹300 each. At that volume, the fixed costs were ₹15·2 lacs and total variable costs were ₹21 lacs. The break-even quantity of product would be

(A) 4000

(B) 7800

(C) 8400

(D) 9500

**65.** A company sells 14,000 units of its product. It has a variable cost of ₹15 per unit. Fixed cost is ₹47,000 and the required profit is ₹23,000. Per unit product price (in ₹) will be

(A) 60

(B) 40

(C) 30

(D) 20

**66.** A project consists of three parallel paths with durations and variances of (10, 4), (12, 4) and (12, 9) respectively. According to the standard PERT assumptions, the distribution of the project duration is

(A) beta with mean 10 and standard deviation 2

(B) beta with mean 12 and standard deviation 2

(C) normal with mean 10 and standard deviation 3

(D) normal with mean 12 and standard deviation 3

**67.** A project has six activities (*A* to *F*) with respective activity durations 7, 5, 6, 6, 8, 4 days. The network has three paths *A-B*, *C-D* and *E-F*. All the activities can be crashed with the same crash cost per day. The number of activities that need to be crashed to reduce the project duration by 1 day is

(A) 1

(B) 2

(C) 3

(D) 6

**68.** In CPM, the cost slope is determined by

(A) crash cost / normal cost

(B) (crash cost – normal cost) / (normal time – crash time)

(C) normal cost / crash cost

(D) (normal cost – crash cost) / (normal time – crash time)

**69.** The variance of the completion time for a project is the sum of variances of

(A) all activity times

(B) non-critical activity times

(C) critical activity times

(D) activity times of first and last activities of the project

**70.** ABC analysis in materials management is a method of classifying the inventories based on

(A) the value of annual usage of the items

(B) economic order quantity

(C) volume of material consumption

(D) quantity of materials used

**71.** What are the atomic packing factors for BCC and FCC respectively?

(A) 0·7, 0·68

(B) 0·68, 0·7

(C) 0·72, 0·7

(D) 0·65, 0·68

**72.** Which one of the following pairs of axis length ($a$, $b$, $c$) and interaxial angle ($\alpha, \beta, \gamma$) represents the tetragonal crystal system?

(A) $a = b = c$; $\alpha = \beta = \gamma = 90^\circ$

(B) $a = b \neq c$; $\alpha = \beta = \gamma = 90^\circ$

(C) $a \neq b \neq c$; $\alpha = \beta = \gamma = 90^\circ$

(D) $a = b = c$; $\alpha = \beta \neq \gamma = 90^\circ$

**73.** Gibbs' phase rule for binary alloy is given as

(A) $F = C + P$

(B) $F = C - P + 1$

(C) $F = C + P - 1$

(D) $F = C - P - 1$

**74.** Match ***List—I*** with ***List—II*** :

| ***List—I*** **( Name of phase )** | ***List—II*** **( Max solubility of carbon )** |
|---|---|
| *(a)* $\alpha$-ferrite | *(i)* 6·67% |
| *(b)* $\gamma$-austenite | *(ii)* 0·10% |
| *(c)* $\delta$-ferrite | *(iii)* 0·025% |
| *(d)* Cementite | *(iv)* 2·0% |

***Code :***

(A) *(a)-(iii), (b)-(iv), (c)-(ii), (d)-(i)*

(B) *(a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)*

(C) *(a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)*

(D) *(a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)*

**75.** TTT diagram indicates time and temperature transformation of

(A) ferrite

(B) pearlite

(C) cementite

(D) austenite

**76.** For a closed system, the difference between the heat added to the system and the work done by the system is equal to the change in

(A) enthalpy

(B) entropy

(C) temperature

(D) internal energy

77. A Carnot engine operates between 27 °C and 327 °C. If the engine produces 300 kJ of work, what is the entropy change during heat addition?

(A) 0·5 kJ/K

(B) 1 kJ/K

(C) 1·5 kJ/K

(D) 2 kJ/K

78. For a reversible power cycle, the operating temperature limits are 800 K and 300 K. It takes 400 kJ of heat. The unavailable work will be

(A) 250 kJ

(B) 150 kJ

(C) 120 kJ

(D) 100 kJ

79. The specific heat of an ideal gas depends on its

(A) temperature

(B) pressure

(C) volume

(D) molecular weight and structure

80. An insulated box containing 0·5 kg of a gas having $C_v$ = 0·98 kJ/kgK falls from a balloon 4 km above the earth's surface. What will be the temperature rise of the gas when the box hits the ground?

(A) 0 K

(B) 20 K

(C) 40 K

(D) 60 K

81. As compared to air standard cycle, in actual working, the effect of variations in specific heats is to

(A) increase maximum pressure and maximum temperature

(B) reduce maximum pressure and maximum temperature

(C) increase maximum pressure and decrease maximum temperature

(D) decrease maximum pressure and increase maximum temperature

82. The number of degrees of freedom for a diatomic molecule is

(A) 2

(B) 3

(C) 4

(D) 5

83. With increase of pressure, the latent heat of steam

(A) remains same

(B) increases

(C) decreases

(D) behaves unpredictably

84. When wet steam flows through a throttle valve and remains wet at exit

(A) its temperature and quality increase

(B) its temperature decreases but quality increases

(C) its temperature increases but quality decreases

(D) its temperature and quality decrease

**85.** Variation of pressure and volume at constant temperature are correlated through

(A) Charles law

(B) Boyle's law

(C) Joule's law

(D) Gay-Lussac's law

**86.** An industrial heat pump operates between the temperatures of 27 °C and 13 °C. The rates of heat addition and heat rejection are 750 W and 1000 W respectively. The COP for the heat pump is

(A) 7·5

(B) 6·5

(C) 4·0

(D) 3·0

**87.** It is proposed to build a refrigeration plant for a cold storage to be maintained at –3 °C. The ambient temperature is 27 °C. If $5 \times 10^6$ kJ/h of energy is to be continuously removed from the cold storage, the minimum power required to run the refrigerator will be

(A) 14·3 kW

(B) 75·3 kW

(C) 154·3 kW

(D) 245·3 kW

**88.** Air cooling is used for freon compressors whereas water jacketing is adopted for cooling ammonia compressors. This is because

(A) latent heat of ammonia is higher than that of freon

(B) thermal conductivity of water is higher than that of air

(C) specific heat of water is higher than that of air

(D) of the larger superheat horn of ammonia compression cycle

**89.** A single-stage vapour compression refrigeration system ***cannot*** be used to produce ultra-low temperatures because

(A) refrigerants for ultra-low temperatures are not available

(B) lubricants for ultra-low temperatures are not available

(C) volumetric efficiency will decrease considerably

(D) heat leakage into the system will be excessive

**90.** Excessive pressure drop in liquid line in a refrigerating system causes

(A) high condenser pressure

(B) flashing of the liquid refrigerant

(C) higher evaporator pressure

(D) undercooling of the liquid refrigerant

**91.** Which of the following refrigerants has the maximum ozone depletion in the stratosphere?

(A) Ammonia

(B) Carbon dioxide

(C) Sulphur dioxide

(D) Fluorine

**92.** In milk chilling plants, the usual secondary refrigerant is

(A) ammonia solution

(B) sodium silicate

(C) propylene glycol

(D) brine

**93.** The leaks in a refrigeration system freon are detected by

(A) a halide torch, which on detecting produces greenish flame lighting

(B) sulphur sticks, which on detecting give white smoke

(C) using reagents

(D) sensing reduction in pressures

**94.** Which one of the following refrigerants has the highest critical temperature?

(A) Water

(B) Carbon dioxide

(C) Freon-12

(D) Ammonia

**95.** A furnace is made up of a red brick wall of thickness 0·5 m and conductivity 0·7 W/mK. For the same heat loss and temperature drop, this can be replaced by a layer of diatomite earth of conductivity 0·14 W/mK and thickness

(A) 0·05 m

(B) 0·1 m

(C) 0·2 m

(D) 0·5 m

**96.** A composite wall having three layers of thickness 0·3 m, 0·2 m and 0·1 m and of thermal conductivities 0·6, 0·4 and 0·1 W/mK respectively, is having surface area 1 $m^2$. If the inner and outer temperatures of the composite wall are 1840 K and 340 K respectively, what is the rate of heat transfer?

(A) 150 W

(B) 1500 W

(C) 75 W

(D) 750 W

**97.** The effectiveness of a fin will be maximum in an environment with

(A) free convection

(B) forced convection

(C) radiation

(D) convection and radiation

**98.** Fins are made as thin as possible to

(A) reduce the total weight

(B) accommodate more number of fins

(C) increase the width for the same profile area

(D) improve the flow of coolant around the fin

**99.** The ratio of energy transferred by convection to that by conduction is called

(A) Stanton number

(B) Nusselt number

(C) Biot number

(D) Pêclet number

**100.** The tendency of petrol to detonate in terms of octane number is determined by comparison of fuel with which of the following?

(A) Iso-octane

(B) Mixture of normal heptane and iso-octane

(C) Alpha methyl naphthalene

(D) Mixture of methane and ethane

**101.** Knocking tendency in a SI engine reduces with increasing

(A) compression ratio

(B) wall temperature

(C) supercharging

(D) engine speed

**102.** The volumetric efficiency of a well-designed SI engine is in the range of

(A) 40%–50%

(B) 50%–60%

(C) 60%–70%

(D) 70%–90%

**103.** The delay period in CI engine depends upon which of the following?

(A) Temperature and pressure in the cylinder at the time of injection

(B) Nature of fuel mixture strength

(C) Relative velocity between the fuel injection and air turbulence pressure of residual gases

(D) All of the above

**104.** The knocking tendency in compression ignition engines increases with

(A) increase of coolant water temperature

(B) increase of temperature of inlet air

(C) decrease of compression ratio

(D) increase of compression ratio

**105.** If the performance of diesel engines of different sizes, cylinder dimensions and power ratings are to be compared, which of the following parameters can be used for such comparison?

(A) Swept volume

(B) Air-fuel ratio

(C) Specific brake fuel consumption

(D) Volumetric efficiency

**106.** A 4-stroke diesel engine, when running at 2000 rpm, has injection duration of 1·5 ms. What is the corresponding duration of the crank angle in degrees?

(A) 18°

(B) 9°

(C) 36°

(D) 15°

**107.** Divided chamber diesel engines use lower injection pressures compared to open chamber engines because

(A) pintle nozzles cannot withstand high injection pressures

(B) high air swirl does not require high injection pressures for atomization

(C) high injection pressure may cause overpenetration

(D) high injection pressure causes leakage of the fuel at the pintle

**108.** In some carburettors, meter rod and economizer device is used for

(A) cold starting

(B) idling

(C) power enrichment

(D) acceleration

**109.** The two reference fuels used for cetane rating are

(A) cetane and iso-octane

(B) cetane and tetraethyllead

(C) cetane and *n*-heptane

(D) cetane and $\alpha$-methylnaphthalene

**110.** In electronic power steering, the torque sensor is nothing but

(A) speed sensor

(B) position sensor

(C) Hall effect sensor

(D) magnetic effect sensor

**111.** In automobile ignition system, the ignition component that steps up voltage is the

(A) battery

(B) ignition coil

(C) capacitor

(D) distributor

**112.** Pitching moment is influenced by ____ in a moving vehicle.

(A) lift force

(B) crosswind force

(C) drag force

(D) side thrust

**113.** The spark plug gap can be checked by

(A) feeler gauge

(B) pressure gauge

(C) vacuum gauge

(D) manometer

**114.** The Venturi in the carburettor causes

(A) increase in air velocity

(B) decrease in air velocity

(C) decrease in fuel flow

(D) decrease in manifold vacuum

**115.** In disc brake, the disc is attached to the

(A) wheel

(B) suspension system

(C) cylinder

(D) axle

**116.** In a four-stroke cycle diesel engine, the exhaust valve

(A) opens at 30° before bottom dead centre and closes at 10° after top dead centre

(B) opens at bottom dead centre and closes at top dead centre

(C) opens at 30° after bottom dead centre and closes at 10° before top dead centre

(D) may open and close anywhere

**117.** The function of a charging system in an automobile is to

(A) supply electric power

(B) convert mechanical energy into electrical energy

(C) partly convert engine power into electrical power

(D) continually recharge the battery

**118.** Which one of the following is mounted between the engine and gearbox?

(A) Propeller shaft

(B) Differential

(C) Clutch

(D) Reduction gear

**119.** Overdrive is provided in the transmission of a vehicle to

(A) reach higher road speeds

(B) improve fuel consumption

(C) achieve better acceleration

(D) carry more load

**120.** The loads supported by an automobile frame are

(A) weight of the body, passengers and cargo loads

(B) torque from engine and transmission

(C) sudden impacts from collisions

(D) All of the above

**121.** The angle between the steering axis and the vertical in the plane of the wheel is called

(A) castor

(B) steering axis inclination

(C) camber

(D) kingpin inclination

**122.** Which of the following clutch arrangements is used in the synchromesh gearbox?

(A) Single plate clutch

(B) Dog clutch

(C) Centrifugal clutch

(D) Fluid clutch

**123.** The main function of gearbox is

(A) to vary the speed of the vehicle

(B) to vary the acceleration of the vehicle

(C) to vary the power of the vehicle

(D) to vary the torque of the vehicle

**124.** A Hooke's joint is used to connect two

(A) coplanar and non-parallel shafts

(B) non-coplanar and non-parallel shafts

(C) coplanar and parallel shafts

(D) non-coplanar and parallel shafts

**125.** The pressure gauges $G_1$ and $G_2$ are installed on the system, shown in the Fig. Pressures of $P_{G_1} = 5{\cdot}00$ bar and $P_{G_2} = 1{\cdot}00$ bar. The value of unknown pressure $P$ is

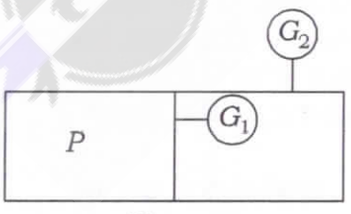


Fig.

(A) 1·01 bar

(B) 2·01 bar

(C) 5·00 bar

(D) 7·01 bar

**126.** A hinged gate of length 5 m, inclined at 30° with the horizontal and with water mass on its left, is shown in Fig. below. Density of water is 1000 kg/m$^2$. The minimum mass of the gate in kg per unit width (perpendicular to the plane of paper), required to keep it closed is

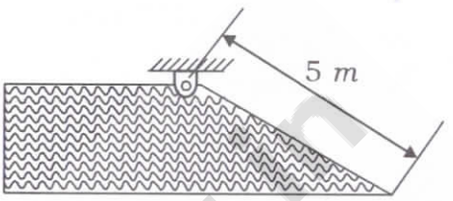


Fig.

(A) 5000

(B) 6600

(C) 7546

(D) 9623

**127.** In a two-dimensional velocity field with velocities $u$ and $v$ along the $X$ and $Y$ directions respectively, the convective acceleration along the $X$ direction is given by

(A) $u\dfrac{\partial u}{\partial x} + v\dfrac{\partial u}{\partial y}$

(B) $u\dfrac{\partial u}{\partial x} + v\dfrac{\partial v}{\partial y}$

(C) $u\dfrac{\partial v}{\partial x} + v\dfrac{\partial u}{\partial y'}$

(D) $v\dfrac{\partial u}{\partial x} + u\dfrac{\partial u}{\partial y}$

**128.** For an incompressible flow field $\vec{v}$, which one of the following conditions must be satisfied?

(A) $\nabla \cdot \vec{v} = 0$

(B) $\nabla \times \vec{v} = 0$

(C) $\left(\vec{v} \cdot \nabla\right) \times \vec{v} = 0$

(D) $\dfrac{\partial V}{\partial t} + \left(\vec{v} \cdot \nabla\right)\vec{v} = 0$

**129.** A syringe with a frictionless plunger contains water (Fig.) and has at its end a 100 mm long needle of 1 mm diameter. The internal diameter of the syringe is 10 mm. Water density is 1000 kg/m$^3$. The plunger is pushed in at 10 mm/s and the water comes out as a jet.

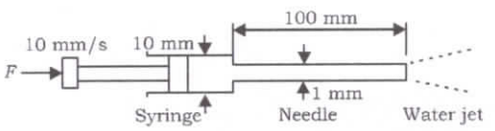


Fig.

Assuming ideal flow, the force $F$ in Newton required on the plunger to push out the water is

(A) 0

(B) 0·04

(C) 0·13

(D) 1·15

**130.** Water is flowing through a horizontal pipe of diameter 200 mm at a velocity of 3 m/s. A circular solid plate of diameter 150 mm is placed in the pipe to obstruct the flow. What is the loss of head due to obstruction in the pipe, if $C_c = 0{\cdot}62$?

[Take $g = 9{\cdot}81$ m/s$^2$]

(A) 3·311 m

(B) 4·211 m

(C) 5·211 m

(D) 6·211 m

**131.** A flat plate of 0·1 m$^2$ area is pulled at 30 cm/s relative to another plate located at a distance of 0·01 cm from it, the fluid separating them being water with viscosity of 0·001 Ns/m$^2$, the power required to maintain velocity will be

(A) 0·05 W

(B) 0·07 W

(C) 0·09 W

(D) 0·11 W

**132.** When the pressure of liquid is increased from 3 MN/m$^2$ to 6 MN/m$^2$, its volume is decreased by 0·1%. The bulk modulus of elasticity of the liquid will be

(A) $3 \times 10^{12}$ N/m$^2$

(B) $3 \times 10^{9}$ N/m$^2$

(C) $3 \times 10^{8}$ N/m$^2$

(D) $3 \times 10^{4}$ N/m$^2$

**133.** A flat plate of area $1{\cdot}5 \times 10^6$ mm$^2$ is pulled with a speed of 0·4 m/s relative to another plate located at a distance of 0·15 mm from it. What is the power required to maintain this speed, if the fluid separating them is having viscosity as 1 poise?

(A) 160 W

(B) 158 W

(C) 145 W

(D) 130 W

**134.** A fluid of viscosity 0·7 Ns/m$^2$ and specific gravity 1·3 is flowing through a circular pipe of diameter 100 mm. The maximum shear stress at the pipe wall is given as 196·2 N/m$^2$. What is the pressure gradient of the flow?

(A) 7848 N/m$^2$ per m

(B) –7848 N/m$^2$ per m

(C) –9848 N/m$^2$ per m

(D) 9848 N/m$^2$ per m

**135.** Consider a steam power plant using a reheat cycle as shown in Fig. Steam leaves the boiler and enters the turbine at 4 MPa, 350 °C ($h_3$ = 3095 kJ/kg). After expansion in the turbine to 400 kPa ($h_4$ = 2609 kJ/kg), the steam is reheated to 350 °C ($h_5$ = 3170 kJ/kg) and then expanded in a low-pressure turbine to 10 kPa ($h_6$ = 2165/kJ/kg).

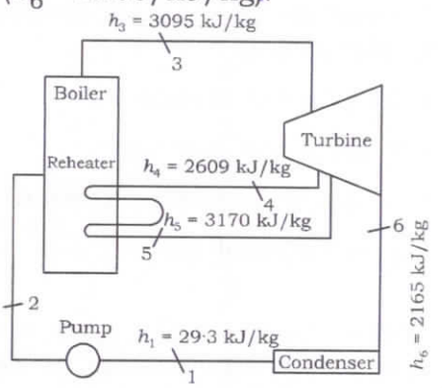


Fig.

The thermal efficiency of the plant neglecting pump work is

(A) 15·8%

(B) 41·1%

(C) 48·5%

(D) 58·6%

**136.** The vapour compression refrigeration cycle is represented as shown in the Fig. below, with state 1 being the exit of the evaporator. The coordinate system used in this figure is

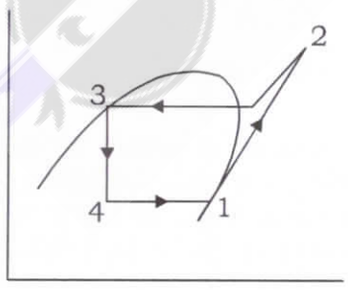


Fig.

(A) *p-h*

(B) *T-s*

(C) *p-s*

(D) *t-h*

**137.** The values of enthalpy of steam at inlet and outlet of a steam turbine in a Rankine cycle are 2800 kJ/kg and 1800 kJ/kg respectively. Neglecting pump work, the specific steam consumption in kg/kW-hour is

(A) 3·60

(B) 0·36

(C) 0·06

(D) 0·01

**138.** Steam enters an adiabatic turbine operating at steady state with an enthalpy of 3251·0 kJ/kg and leaves as a saturated mixture at 15 kPa with quality (dryness fraction) 0·9. The enthalpies of the saturated liquid and vapour at 15 kPa are $h_f$ = 225·94 kJ/kg and $h_g$ = 2598·3 kJ/kg respectively. The mass flow rate of steam is 10 kg/s. Kinetic and potential energy changes are negligible. The power output of the turbine in MW is

(A) 6·5

(B) 8·9

(C) 9·1

(D) 27·0

**139.** Which one of the following statements is ***correct***?

(A) In water tube boiler, water surrounds the tubes and hot gases are inside the tubes

(B) The boilers which produce steam at pressures of 10 bar and below are called high pressure boilers

(C) Lancashire boilers are externally fired boilers

(D) Stirling boilers are externally fired boilers

**140.** In a power plant, the efficiencies of the electric generator, turbine (mechanical), boiler, cycle and overall plant are 0·97, 0·95, 0·92, 0·42 and 0·33 respectively. What percentage of the total electricity generated is consumed in running the auxiliaries?

(A) 9·29%

(B) 8·50%

(C) 7·32%

(D) 6·76%

**141.** The ratio of Euler's buckling loads of columns with the same parameters having *(a)* both ends fixed and *(b)* both ends hinged is

(A) 2

(B) 4

(C) 6

(D) 8

**142.** In power transmission shafts, if the polar moment of inertia of a shaft is doubled, then what is the torque required to produce the same angle of twist?

(A) 1/4 of the original value

(B) 1/2 of the original value

(C) Same as the original value

(D) Double the original value

**143.** Which one of the following is represented by the area of the S.F. diagram from one end up to a given location on the beam?

(A) B.M. at the location

(B) Load at the location

(C) Slope at the location

(D) Deflection at the location

**144.** The piston rod and the crosshead in a steam engine are usually connected by means of

(A) cotter joint

(B) knuckle joint

(C) ball joint

(D) universal joint

**145.** A body having weight of 1000 N is dropped from a height of 10 cm over a close coiled helical spring of stiffness 200 N/cm. The resulting deflection of spring is nearly

(A) 5 cm

(B) 16 cm

(C) 35 cm

(D) 100 cm

**146.** A key connecting a flange coupling to a shaft is likely to fail in

(A) shear

(B) tension

(C) torsion

(D) bending

**147.** In a plate cam mechanism with reciprocating roller follower, the follower has a constant acceleration in the case of

(A) cycloidal motion

(B) parabolic motion

(C) simple harmonic motion

(D) polynomial motion

**148.** When two shafts are neither parallel nor intersecting, power can be transmitted by using

(A) a pair of spur gears

(B) a pair of helical gears

(C) an Oldham's coupling

(D) a pair of spiral gears

**149.** If the momentum of a given particle is doubled, then its kinetic energy will be

(A) doubled

(B) quadrupled

(C) halved

(D) unaffected

**150.** The power required by a machine having an efficiency of 80% for raising a load of 24 N through a distance of 36 m in 1 minute is

(A) 12 W

(B) 18 W

(C) 50 W

(D) 450 W

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