**T.B.C. : FGT-B-MCH**

**Test Booklet Series**

Serial **1003911**

**C**

## TEST BOOKLET

## MECHANICAL ENGINEERING

*Time Allowed : Three Hours*

*Maximum Marks : 300*

### 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 Code 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.

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4. This Test Booklet contains **150** 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 (0·33)** 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.
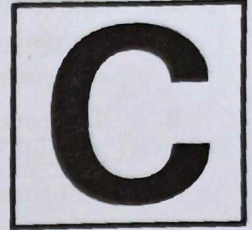
**DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE TOLD TO DO SO**

1. Consider the following statements regarding mechatronics systems :

   1. The anti-lock brakes on a car are a simple example of a real time computing system.

   2. The completion of an operation after its deadline is considered useless in soft real time system.

   3. The hard real time system tolerates lateness and may respond with decreased service quality.

   Which of the above statements is/are correct ?

   (a) 1 only

   (b) 2 and 3 only

   (c) 3 only

   (d) 1, 2 and 3

2. Which one of the following materials has least piezoelectric charge sensitivity ?

   (a) Quartz

   (b) Barium Titanate

   (c) PZT

   (d) PVDF

3. The ideal hydraulic rotary actuator provides shaft torque, T, which is

   (a) equal to displaced volume measured.

   (b) inversely proportional to the displaced volume measured.

   (c) proportional to the differential pressure.

   (d) inversely proportional to the differential pressure.

4. An ammeter requires a change of 3 A in its coil to produce a change in deflection of the pointer by 12 mm. What is the static sensitivity ?
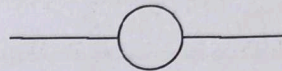
   (a) 36 mm/A

   (b) 9 mm/A

   (c) 4 mm/A

   (d) 15 mm/A

5. What is the force needed to apply to a piston of 2 cm radius in order to result a force of 6000 N at the working piston of radius 6 cm ?

   (a) 1334 N

   (b) 333 N

   (c) 1050 N

   (d) 667 N

6. The following symbol in the ladder logic represents :

   

   (a) Normally open contacts

   (b) Normally closed contacts

   (c) Output loads

   (d) Special instruction

7. The settling time for a unit step response of a second-order system is

   (a) proportional to the natural frequency.

   (b) inversely proportional to the natural frequency.

   (c) equal to the damping ratio.

   (d) proportional to the damping ratio.

8. A typical wrist mechanism with three rotational joints would be indicated by

   (a) TRL

   (b) TRT

   (c) LLL

   (d) TRR

9. The Analog-to-Digital conversion process involves :

   1. Quantizing

   2. Sampling

   3. Encoding

   What is the correct sequence ?

   (a) 2-1-3

   (b) 2-3-1

   (c) 3-1-2

   (d) 3-2-1

**Directions :** *Each of the next six (06) items consists of two statements, one labelled as 'Statement (I)' and the other labelled as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the codes given below :*

**Codes :**

(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.

**10.** Statement (I) :

Gravity is the driving force behind flows through open channels.

Statement (II) :

Gravity stands to reason that the ratio of inertial to gravitational forces will play a major role in open channel flow analysis.

**11.** Statement (I) :

The viscosity of liquids decreases with the increase of temperature while the viscosity of gases increases with the increase of temperature.

Statement (II) :

The viscous forces in a fluid are due to cohesive forces and molecular momentum transfer.

**12.** Statement (I) :

If two systems are in thermal equilibrium with a third system, then they are not in thermal equilibrium with each other.

Statement (II) :

Zeroth law of thermodynamics is the basis for temperature.

**13.** Statement (I) :

A thermal energy reservoir is a system that always remains at constant temperature even though the heat is added to or removed from it.

Statement (II) :

A thermal reservoir that supplies heat energy is called sink and one that absorbs the heat energy is called source.

**14.** Statement (I) :

Wear is an issue whenever two components operate with relative motion between them or when liquids or solids impinge on a surface at high velocity.

Statement (II) :

Wear is often cumulative and can eventually render the components incapable of delivering their expected performance.

**15.** Statement (I) :

Increased productivity, reduced cost of labour and improved quality can be achieved by automation.

Statement (II) :

Due to automation in process inventory, dependence on operator skills may be increased.

16. Which one of the following lubricants is used in forward hot extrusion of steel ?
    (a) Molten glass
    (b) Soap solution
    (c) Copper sulphate
    (d) Vegetable oil

17. Which one of the following statements is **not** the correct statement regarding operating characteristics (OC) curve for sampling plan ?
    (a) It shows ability to distinguish between good and bad lots.
    (b) No sampling plans can give complete protection against acceptance of defectives.
    (c) Larger the sample size, steeper is the slope of the curve.
    (d) Acceptance number is zero for ideal sampling plan.

18. Which one of the following statements is **not** correct for forward or direct extrusion process ?
    (a) High friction forces must be overcome.
    (b) High extrusion forces are required but mechanically simple and uncomplicated.
    (c) Low scrap or material waste only 5 – 6% of billet weight.
    (d) Simple, but the material must slide along the chamber wall.

19. Consider the following statements regarding defects in forgings :
    1. Flakes are internal breaks or ruptures occurring in some grades of alloy steel.
    2. Die shift is caused by misalignment between the top and bottom forging dies.
    3. Fins and rags are small projections or loose metal driven into the surface of the forging.
    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

20. Consider the following statements regarding desirable properties of cutting fluid :
    1. It should get oxidised when left in air.
    2. It should react with the materials of machine tool parts.
    3. It should wet the surface of cutting tool and workpiece.
    Which of the above statements is/are correct ?
    (a) 2 only
    (b) 3 only
    (c) 2 and 3 only
    (d) 1, 2 and 3

21. Consider the following statements regarding limits and fits :
    1. Actual size is the standard size for the part and is the same both for the hole and its shaft.
    2. Basic size is the dimension as measured on the manufactured part.
    3. Deviation is the algebraic difference between a size and the corresponding basic size.
    Which of the above statements is/are correct ?
    (a) 3 only
    (b) 1 and 3 only
    (c) 2 only
    (d) 1, 2 and 3

22. Which of the following statements is **not** correct about PERT ?
    (a) Network is constructed based on the events.
    (b) It does not take uncertainties involved in the estimation of times.
    (c) Network deals with uncertainties and hence three time estimations are considered.
    (d) As there is no certainty of time, activity duration cannot be reduced.

23. Parallel misalignment is present when

   (a)   two shafts are parallel to each other but are not in the same plane.

   (b)   two shafts are parallel to each other and are in the same plane.

   (c)   the shafts are not parallel to each other.

   (d)   the shafts are aligned with each other.

24. The major limitation with displacement or proximity probes is

   (a)   Size

   (b)   Time

   (c)   Accuracy

   (d)   Cost

25. Which one of the following contains design data on all products, e.g., their constituent components and parts ?

   (a)   Engineering data master file

   (b)   Process data master file

   (c)   Inventory master file

   (d)   Sales master file

26. Which one of the following is the cutter with a curved tooth outline of the same shape as the profile of the workpiece ?

   (a)   Plain milling cutter

   (b)   Face milling cutter

   (c)   End milling cutter

   (d)   Profile milling cutter

27. Which one of the following is a joining process that may employ acetylene, natural gas, butane in combination with oxygen to supply the heat required to melt the filler rod and diffuse it into the surface of the base metal ?

   (a)   Furnace brazing

   (b)   Torch brazing

   (c)   Induction brazing

   (d)   Dip brazing

28. Consider the following statements regarding modulation :

   1.   The modulation is essential in communication systems, where a weak signal is transmitted by the use of a carrier signal.

   2.   When the frequency of the high frequency signal is varied in accordance with the intensity of the low-frequency weak signal, the modulation is said to be frequency modulation.

   3.   The process of recovering original baseband signal from the modulated signal is called phase modulation.

Which of the above statements are correct ?

   (a)   1 and 3 only

   (b)   1 and 2 only

   (c)   2 and 3 only

   (d)   1, 2 and 3

29. Consider the situation where a microprocessor gives an output of an 8-bit word. This is fed through an 8-bit digital-to-analog converter to a control valve. The control valve requires 6·0 V to be fully open. If the fully open state is indicated by 11111111, then what is the output to the valve for a change of 1 bit ?

   (a)   0·033 V

   (b)   0·053 V

   (c)   0·043 V

   (d)   0·023 V

30. Which one of the following is _not_ an application of Hall effect sensor ?

   (a)   Magnetic switch for electric transducer

   (b)   Measurement of current

   (c)   Measurement of acceleration

   (d)   Measurement of power

**31.** The compound gear train shown in the figure below consists of compound gear B-C and D-E. All gears are mounted on parallel shafts. The motor shaft rotating at 800 rpm is connected to the gear A and the output shaft to the gear F. The number of teeth on gears A, B, C, D, E and F are 24, 56, 30, 80, 32 and 72 respectively. What is the speed of the gear F?



(a) 57·14 rpm

(b) 32·51 rpm

(c) 74·63 rpm

(d) 69·72 rpm
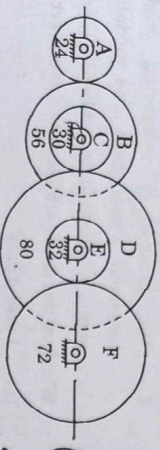
**32.** A quick-return mechanism is to be designed, where the outward stroke must consume 1·2 s and the return stroke 0·8 s. If the cycle time is 2·0 s/rev, what is the speed at which the mechanism should be driven?

(a) 10 rev/s

(b) 30 rev/s

(c) 10 rev/min

(d) 30 rev/min

**33.** The following data relate to a single-cylinder reciprocating engine : mass of reciprocating parts = 40 kg, mass of revolving parts = 30 kg at crank radius, speed = 150 rpm, stroke = 350 mm. If 60% of the reciprocating parts and all the revolving parts are to be balanced, what is the balance mass required at a radius of 320 mm?

(a) 15·27 kg

(b) 21·43 kg

(c) 24·96 kg

(d) 29·53 kg

**34.** A leaf spring consists of seven steel plates, each 60 mm wide and 6 mm thick. What is the length of the spring if it is to carry a central load of 3 kN, without the stress exceeding 150 MPa?

(a) 547 mm

(b) 498 mm

(c) 494 mm

(d) 504 mm

**35.** According to maximum shear stress theory, with comparison to yield strength in tension, the yield strength in shear is

(a) half the yield strength in tension.

(b) same as that of yield strength in tension.

(c) double the yield strength in tension.

(d) 1·33 times that of the yield strength in tension.

**36.** In curved beams, normally the nature of stress distribution is

(a) linear

(b) circular

(c) parabolic

(d) hyperbolic

**37.** Consider the following statements regarding crack :

1. Crack is more likely to occur in the regions of discontinuity such as oil holes.

2. Crack is more likely to occur in the regions of irregularities in machining operations such as stamp mark.

3. Crack is more likely to occur in the internal cracks due to defects in materials like blow holes.

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

**38.** The yield strength of bolt material is 300 MPa and factor of safety is 2·5. What is the maximum principal stress using maximum principal stress theory ?

(a) 750 MPa

(b) 120 MPa

(c) 27·38 MPa

(d) 10·95 MPa

**39.** Which one of the following theories gives satisfactory results for brittle materials ?

(a) Maximum principal stress theory

(b) Maximum shear stress theory

(c) Distortion energy theory

(d) Shear stress energy theory

**40.** A cast steel bar having an ultimate strength of 120 MPa is subjected to a reversed, repeated, bending load. The bar will be machined to a rectangular cross-section, 150 mm wide × 200 mm high. What is the equivalent diameter ?

(a) 14 mm

(b) 30 mm

(c) 140 mm

(d) 300 mm

**41.** Consider the following statements regarding typical analysis of bolt failure :

1. 15% failure of bolt occur at the fillet under the head.

2. 50% failure of bolt occur at the end of threads on the shank.

3. 80% failure of bolt occur in the threads that are in contact with the nut.

Which of the above statements is/are correct ?

(a) 1 only

(b) 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

**42.** Which of the following are the functions of lubrication in a bearing unit ?

1. To protect the bearing components from corrosion.

2. To absorb heat from the bearing unit.

3. To carry heat away from the bearing unit.

Select the correct answer using the code given below :

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

**43.** Consider the following statements regarding clutches:

1. Dry clutch has higher coefficient of friction compared to wet clutch.
2. The torque capacity of wet clutch is high compared to dry clutch.
3. The engagement in a dry clutch is smoother than in case of wet clutch.

Which of the above statements is/are correct?

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

**44.** Which of the following factors can cause misalignment of the teeth on the pinion relative to those on the gear?

1. Inaccurate gear teeth
2. Misalignment of the axes of shafts carrying gears
3. Thermal distortions during operation

Select the correct answer using the code given below:

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

**45.** Consider the following statements regarding welded and riveted joints:

1. Welded assemblies are tight and leak proof as compared with riveted assemblies.
2. Single-welded V-joint is less reliable than square butt joint.
3. Welding results in a thermal distortion of the parts, thereby inducing residual stresses.

Which of the above statements is/are correct?

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

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**46.** Iron at 20°C is BCC with atoms of atomic radius 0·124 nm. What is the lattice constant 'a' for the cube edge of the iron unit cell?

(a) 0·2864 nm
(b) 0·1496 nm
(c) 0·2173 nm
(d) 0·1756 nm

**47.** Copper has the FCC crystal structure and a unit cell with a lattice constant of 0·361 nm. What is the interplanar spacing $d_{220}$?

(a) 0·085 nm
(b) 0·174 nm
(c) 0·206 nm
(d) 0·128 nm

**48.** Which one of the following is *not* a step of lever rule of determination of phase amounts?

(a) A tie line is constructed across the two-phase region at the temperature of the alloy.
(b) The overall alloy composition is located on the tie line.
(c) Perpendiculars are dropped from these intersections to the horizontal composition axis, from which the composition of each of the respective phases is read.
(d) The fraction of one-phase is computed by taking the length of tie line from the overall alloy composition to the phase boundary for the other phase and dividing by the total tie line length.

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**49.** Consider the following statements regarding polymeric materials:

1. A plastic material that requires heat to make it formable (plastic) and upon cooling, retains its shape is known as thermosetting plastic.
2. The chemical reaction in which high molecular mass molecules are formed from two or more monomers is called chain polymerization.
3. A polymer chain consisting of two or more types of monomeric units is called copolymer.

Which of the above statements is/are correct?

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

**50.** As per mechanical properties, which one of the following microconstituents is soft and ductile?

(a) Bainite
(b) Martensite
(c) Spheroidite
(d) Tempered martensite

**51.** The simultaneous compaction and shaping of a ceramic powder (and binder) by pressure applied uniformly in all directions is known as

(a) Glaze pressing
(b) Porcelain pressing
(c) Slip pressing
(d) Isostatic pressing

**52.** An electric motor drives a punching press. A flywheel fitted to the press has a radius of gyration of 0·5 m and runs at 250 rpm. The press is capable of punching 800 holes per hour with each punching operation taking 1·5 seconds and requiring 12,000 N-m of work. The energy delivered by the motor during punching operation is

(a) 2000 N-m
(b) 3000 N-m
(c) 4000 N-m
(d) 5000 N-m

**53.** A linkage has 11 links and 4 loops. What is the degree of freedom if it has only single turning pairs?

(a) 0
(b) 1
(c) 2
(d) 3

**54.** Which one of the following is the application of first inversion of single-slider-crank chain?

(a) Hand-pump
(b) Reciprocating engine
(c) Elliptical trammel
(d) Whitworth quick-return mechanism

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(8—C)

(9—C)

55. Consider the following statements regarding cams :

1. A cam in which the follower moves radially from the centre of rotation of the cam is known as a disc cam.

2. A globoidal cam is a double-disc cam.

3. A conjugate cam can have two types of surfaces, convex or concave.

4. In a spherical cam, the follower oscillates about an axis perpendicular to the axis of rotation of the cam.

Which of the above statements are correct ?

(a) 1 and 4 only

(b) 2 and 4 only

(c) 2 and 3 only

(d) 1, 2, 3 and 4

56. Under which of the following conditions is Coriolis component encountered in the relative acceleration of two points ?

1. The two points are coincident, but on different links.

2. The point on one link traces a path on the other link.

3. The link that contains the path rotates.

Select the correct answer using the code given below :

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

57. A mass 'm' attached to a light spring oscillates with a period of 2 seconds. If the mass is increased by 2 kg, the period increases by 1 second. What is the value of the mass ?

(a) 0·9 kg

(b) 1·6 kg

(c) 2·1 kg

(d) 2·7 kg

58. What is the critical speed of the shaft if its natural frequency of transverse vibration is 2·85 Hz ?

(a) 171 rpm

(b) 285 rpm

(c) 570 rpm

(d) 142·5 rpm

59. Consider the following statements regarding gears :

1. The ratio of number of teeth on the gear to that on the pinion is known as gear ratio.

2. The circle passing through the tips of teeth is called dedendum circle.

3. The circle passing through the roots of teeth is called addendum circle.

4. Backlash is the difference between the space width and the tooth thickness along the pitch circle.

Which of the above statements are correct ?

(a) 1, 2 and 3 only

(b) 1 and 4 only

(c) 2 and 3 only

(d) 1, 2, 3 and 4

60. The number of teeth of a spur gear is 30 and it rotates at 200 rpm. What is the pitch line velocity if it has a module of 2 mm ?

(a) 341·7 mm/s

(b) 497·2 mm/s

(c) 628·3 mm/s

(d) 758·5 mm/s

61. A man whose weight is 650 N, standing on the ground, raises a load of 3000 N by means of single string system of pulleys. There are six light pulleys in each block. The thrust of the man on the ground is

(a) 120 N

(b) 135 N

(c) 150 N

(d) 175 N

62. A particle starts with an initial velocity of 200 cm/s and moves with a uniform retardation of 10 cm/s². If it describes 1500 cm in time t, what is/are the possible value(s) of t ?

(a) 10 sec only

(b) 10 sec and 30 sec

(c) 30 sec only

(d) 5 sec and 10 sec

63. Consider the following statements for system of forces :

1. Two or more forces that act at the same point are called coplanar forces.

2. Two or more forces whose directed arrows lie in same plane are called concurrent forces.

3. Varignon's theorem states that 'the moment of several concurrent coplanar forces about any point O in their plane equals the moment of their resultant about the point O'.

4. Lami's theorem states that if a body is in equilibrium under the action of three forces, each force is proportional to the sine of angle between the other forces.

Which of the above statements are correct ?

(a) 1, 2 and 4 only

(b) 1 and 4 only

(c) 3 and 4 only

(d) 1, 2 and 3 only

64. Consider the following statements related to stress and strain :

1. Shear stress is always tangential to the area over which it acts.

2. Shear stresses on the transverse pair of faces are known as complimentary shear stresses.

3. Shear strain is defined as the change in the right angle of the element measured in radians.

4. Modulus of rigidity is the ratio of shear strain to shear stress.

Which of the above statements are correct ?

(a) 1, 3 and 4 only

(b) 2 and 4 only

(c) 3 and 4 only

(d) 1, 2 and 3 only

65. Consider the following statements for stress and strain analysis :

1. The stress components on any inclined plane can easily be found with the help of a geometrical construction known as Mohr's stress circle.

2. The ratio of longitudinal strain to lateral strain is known as Poisson's ratio.

3. When a body is acted upon by three mutually perpendicular forces, there is change in the volume of the body which is referred to as dilation of the material.

4. The ratio of original volume to increase in volume is known as volumetric strain.

Which of the above statements are correct ?

(a) 1 and 3 only

(b) 2 and 4 only

(c) 3 and 4 only

(d) 1, 2, 3 and 4

**66.** The stresses on two perpendicular planes through a point in a body are 160 MPa and 100 MPa, both compressive, along with a shear stress of 80 MPa. What is the normal stress on a plane inclined at 30° to the plane of 160 MPa stress ?

(a) −42·4 MPa

(b) −75·7 MPa

(c) −59·1 MPa

(d) −86·3 MPa

**67.** Consider the following statements regarding types of supports and beams :

1. When both supports of beams are roller supports, the beam is known as simply supported beam.

2. A beam with one end fixed and the other end free is known as fixed beam.

3. A beam with both ends fixed is known as cantilever beam.

4. A beam with one end fixed and the other simply supported is known as propped cantilever.

Which of the above statements is/are correct ?

(a) 1 only

(b) 1 and 4 only

(c) 1, 3 and 4 only

(d) 2, 3 and 4 only

**68.** Consider the following statements regarding stress in beam :

1. If a member is subjected to equal and opposite couples acting in the same longitudinal planes, the member is said to be in pure bending.

2. The internal stresses developed in the beam are known as flexural stresses.

3. There is an intermediate surface known as neutral surface, at which the stress is zero.

4. An axis obtained by intersection of the neutral surface and a cross-section is known as neutral axis.

Which of the above statements are correct ?

(a) 2 and 3 only

(b) 1 and 4 only

(c) 3 and 4 only

(d) 1, 2, 3 and 4

**69.** Consider the following statements for the symmetric beam under pure bending :

1. In the elastic range, the normal stress varies linearly with the distance from the neutral surface.

2. As long as the stresses remain in the elastic range, the neutral axis passes through the centroid of the section.

3. If stresses are in the plastic range, the neutral axis passes through the centroid of the section.

Which of the above statements is/are correct ?

(a) 1 only

(b) 2 only

(c) 1 and 2 only

(d) 2 and 3 only

**70.** The volume of FCC unit cell in terms of the atomic radius R is

(a) $V_c = 16R^3 \sqrt{3}$

(b) $V_c = 8R^3 \sqrt{2}$

(c) $V_c = 16R^3 \sqrt{2}$

(d) $V_c = 8R^3 \sqrt{3}$

**71.** Which one of the following alloying ingredients increases the hardenability and forms carbides for wear resistance ?

(a) Chromium

(b) Molybdenum

(c) Nickel

(d) Manganese

**72.** Which one of the following related to the most stable arrangement of atoms in a crystal is *not* correct ?

(a) Preserves electrical neutrality

(b) Maximizes strong ion-ion repulsion

(c) Satisfies discreteness of all covalent bonds

(d) Packs the atoms as closely as possible

**73.** The dielectric constant of rubber varies between

(a) 0·5 and 1·0

(b) 1·0 and 1·5

(c) 1·5 and 2·0

(d) 2·5 and 5·0

**74.** Consider the following statements for ductile fracture :

1. The material undergoes substantial plastic deformation with high energy absorption before fracture.

2. Presence of cracks on the surface of material initiates this type of failure.

3. Fracture occurs due to necking.

Which of the above statements is/are correct ?

(a) 1 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1 and 3 only

**75.** The TTT diagram shows the times required for isothermal transition from

(a) austenite to pearlite.

(b) austenite to ferrite.

(c) ferrite to pearlite.

(d) martensite to pearlite.

**76.** Water is flowing through a pipe of diameter 200 mm with a velocity of 3 m/s. What is the head loss due to friction for a length of 5 m if the coefficient of friction is given by $f = 0·02 + \dfrac{0·09}{Re^{0·3}}$, where Re is Reynolds number ? (Take the kinematic viscosity of water as 0·01 stoke, $g = 9·81$ m/s² and $(6 \times 10^5)^{0·3} = 54·13$)

(a) 0·993 m of water

(b) 0·783 m of water

(c) 0·685 m of water

(d) 0·552 m of water

**77.** 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 $C_c = 0·62$ ? (Take $g = 9·81$ m/s²)

(a) 3·311 m

(b) 4·211 m

(c) 5·211 m

(d) 6·211 m

**78.** Three pipes of length 800 m, 500 m and 400 m and of diameters 500 mm, 400 mm and 300 mm respectively are connected in series. These pipes are to be replaced by a single pipe of length 1700 m. What is the diameter of the single pipe ?

(a) (0·007118)$^{0·2}$ m

(b) (0·003609)$^{0·3}$ m

(c) (0·003609)$^{0·2}$ m

(d) (0·007118)$^{0·3}$ m

**79.** The head of water at the inlet of a pipe 2000 m long and 500 mm diameter is 60 m. A nozzle of diameter 100 mm at its outlet is fitted to the pipe. What is the velocity of water at the outlet of the nozzle if f = 0.01 for the pipe? (Take g = 9.81 m/s²)

(a) 30·61 m/s
(b) 34·81 m/s
(c) 36·52 m/s
(d) 38·36 m/s

**80.** Water is flowing with a velocity of 1·5 m/s in a pipe of length 2500 m and of diameter 500 mm. At the end of the pipe, a valve is provided. What is the rise in pressure if the valve is closed in 25 seconds? (Take the value of C as 1460 m/s)

(a) 12 N/cm²
(b) 15 N/cm²
(c) 16 N/cm²
(d) 18 N/cm²

**81.** If a submerged body is in unstable equilibrium, then

(a) the centre of buoyancy is below the centre of gravity.
(b) the centre of buoyancy is above the centre of gravity.
(c) meta-centre is below the centre of buoyancy.
(d) meta-centre is above the centre of buoyancy.

**82.** How much of concrete with γ = 25 kN/m³ must be attached to a beam having a volume of 0·1 m³ and specific gravity 0·6 to cause both to sink in water? (Take g = 9·81 m/s²)

(a) 0·825 kN
(b) 0·745 kN
(c) 0·525 kN
(d) 0·645 kN

**83.** A liquid has a specific gravity of 1·9 and a kinematic viscosity of 6 stokes. What is the dynamic viscosity?

(a) 1·14 Ns/m²
(b) 2·44 Ns/m²
(c) 3·40 Ns/m²
(d) 11·40 Ns/m²

**84.** Oil of specific gravity 0·8 flows through a 0·2 m diameter pipe under a pressure of 100 kN/m². If the datum is 5 m below the centerline of the pipe and the total energy with respect to the datum is 35 Nm/N, the discharge is (Take g = 9·81 m/s²)

(a) 0·58 m³/sec
(b) 0·47 m³/sec
(c) 0·31 m³/sec
(d) 0·22 m³/sec

**85.** Bernoulli's equation is obtained by

(a) integrating the Euler's equation of motion.
(b) differentiating the Euler's equation of motion.
(c) differentiating the Navier-Stokes equations.
(d) integrating energy equation.

**86.** Which one of the following is *not* the methodology of control separation of flow from boundary in the application of aerofoils?

(a) Streamlining of blunt body shapes
(b) Fluid ejection from the boundary layer
(c) Suction of fluid from the boundary layer
(d) Creating a motion of the boundary wall

**87.** What is the value of mass of the air in a room of size 4 m × 5 m × 6 m at 100 kPa and 25°C? (Take R = 0·287 kPa.m³.kg⁻¹.K⁻¹)

(a) 150 kg
(b) 180 kg
(c) 140 kg
(d) 130 kg

**88.** A body of weight 100 N is placed on a rough horizontal plane. What is the coefficient of friction if a horizontal force of 60 N just causes the body to slide over the horizontal plane?

(a) 0·4
(b) 0·5
(c) 0·6
(d) 0·9

**89.** A body is moving with a velocity of 2 m/s. After 4 seconds, the velocity of the body becomes 5 m/s. The acceleration of the body is

(a) 0·55 m/s²
(b) 0·65 m/s²
(c) 0·75 m/s²
(d) 0·45 m/s²

**90.** The principal stresses at a point in an elastic material are 60 N/mm² tensile, 20 N/mm² tensile and 50 N/mm² compressive. What is the volumetric strain by considering Young's Modulus as 100 × 10³ N/mm² and μ = 0·3?

(a) 1·20 × 10⁻⁴
(b) 1·06 × 10⁻⁵
(c) 1·30 × 10⁻³
(d) 1·12 × 10⁻²

**91.** In an absorption type refrigeration system, heating in generator, refrigeration in evaporator and cooling by cooling water in condenser, take place at 95°C, –5°C and 30°C respectively. What is the maximum COP of the system?

(a) 1·17
(b) 1·35
(c) 1·52
(d) 1·78

**92.** Consider the following statements for sensible heat factor:

1. Sensible heat factor will be negative if sensible heat and latent heat are both negative.
2. Sensible heat factor will be negative if sensible heat is negative and latent heat is positive.
3. Sensible heat factor will be negative if sensible heat is positive and latent heat is negative.
4. Sensible heat factor will be negative if sensible heat and latent heat are both positive.

Which of the above statements are correct?

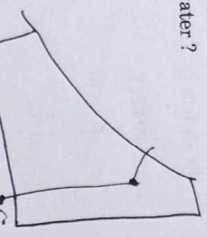(a) 2 and 3 only
(b) 1 and 2 only
(c) 1 and 3 only
(d) 2 and 4 only

**93.** If the air is initially at dry bulb temperature 35°C and wet bulb temperature 26·1°C as it enters an air washer which has a humidifying efficiency of 85%, then what is the final dry bulb temperature of air washed with recirculated spray water ?

(a) 26·81°C
(b) 27·43°C
(c) 32·83°C
(d) 30·49°C

**94.** Consider the following statements for Nucleate boiling :

1. For water, the critical heat flux does not exceed 1 MW/m².

2. Nucleate boiling is the most desirable boiling regime in practice because of high heat transfer rates.

3. Heat flux increases at a higher rate with increase in temperature.

Which of the above statements is/are correct ?

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

**95.** In drop-wise condensation, the heat transfer rate is

(a) 5 times less than that in film-wise condensation.
(b) 15 times less than that in film-wise condensation.
(c) 25 times more than that in film-wise condensation.
(d) 10 times more than that in film-wise condensation.

**96.** 1 kg of water falls from an altitude of 1000 m above ground level. What is the change in the temperature of water at the foot of the fall, if there are no losses during the fall ? (Take specific heat of water as 1 kcal.kg⁻¹.K⁻¹ and g = 9·81 m/s²)

(a) 3·35°C
(b) 2·35°C
(c) 3·32°C
(d) 4·12°C

**97.** A stationary mass of gas is compressed without friction from an initial state of 0·3 m³ and 0·105 MPa to a final state of 0·15 m³ and 0·105 MPa, the pressure remaining constant during the process. There is a transfer of 40 kJ of heat from the gas during the process. How much does the internal energy of the gas change ?

(a) − 24·25 kJ
(b) − 19·62 kJ
(c) − 15·91 kJ
(d) − 12·72 kJ

**98.** The state of a simple compressible pure substance can be fixed by specifying

(a) one independent property.
(b) two independent properties.
(c) three independent properties.
(d) four independent properties.

**99.** In a thermoelectric thermometer for t°C temperature, the emf is given as : E = 0·003t − 5 × 10⁻⁷ t² + 0·5 × 10⁻³ volts. Thermometer is having reference junction at ice point and is calibrated at ice point and steam point. What is the temperature shown by the thermometer for a substance at 30°C ?

(a) 33·23°C
(b) 36·28°C
(c) 41·23°C
(d) 46·28°C

**100.** Consider the following statements for comparison of heat and work :

1. Both heat and work are transient phenomena.

2. Both heat and work are boundary phenomena.

3. Both heat and work are path functions and inexact differentials.

Which of the above statements are correct ?

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

**101.** A tank containing a fluid is stirred by a paddle wheel. The work input to the paddle wheel is 5090 kJ. The heat transfer from the tank is 1500 kJ. What is the change in internal energy of this control mass ? (Consider the tank and the fluid inside a control surface)

(a) − 3590 kJ
(b) + 3590 kJ
(c) + 4590 kJ
(d) − 4590 kJ

**102.** During the charging of a storage battery, the current is 20 A and the voltage is 12·8 V. The rate of heat transfer from the battery is 10 W. At what rate is the internal energy increasing ?

(a) − 256 J/s
(b) + 246 J/s
(c) + 256 J/s
(d) − 246 J/s

**103.** A refrigerator operates on Reversed Carnot cycle. What is the power required to drive the refrigerator between temperatures of 42°C and 4°C, if heat at the rate of 2 kJ/s is extracted from the low temperature region ?

(a) 0·174 kW
(b) 0·374 kW
(c) 0·274 kW
(d) 0·474 kW

**104.** Entropy generated ($S_{gen}$) can be taken as a criterion to indicate feasibility of process. Which of the following conditions are correct ?

1. If $S_{gen} = 0$, then the process is a reversible process.

2. If $S_{gen} > 0$, then the process is an irreversible process.

3. If $S_{gen} < 0$, then the process is impossible.

Select the correct answer using the code given below :

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

**105.** What is the critical radius of insulation for asbestos (thermal conductivity = 0·17 W.m⁻¹.°C⁻¹) surrounding a circular pipe and exposed to room air at 20°C with heat transfer coefficient 3 W.m⁻².°C⁻¹ ?

(a) 7·21 cm
(b) 6·37 cm
(c) 5·67 cm
(d) 6·93 cm

FGT-B-MCH

(16 − C)

(17 − C)

**106.** A turbine develops 8000 kW when running at 1000 rpm. The head on the turbine is 30 m. If the head is reduced to 18 m, what is the speed developed by the turbine?

(a) 67·46 rpm

(b) 95·24 rpm

(c) 54·67 rpm

(d) 77·46 rpm

**107.** The steam turbine can be governed by the following methods *except*

(a) Reaction governing

(b) Throttle governing only

(c) Nozzle control governing only

(d) Combination of throttle and nozzle control governing

**108.** In a gas turbine plant, heat supplied is 667·2 kJ/kg, and heat rejected is 391·43 kJ/kg. What is the thermal efficiency of the plant?

(a) 57·29%

(b) 72·51%

(c) 41·33%

(d) 32·83%

**109.** The constant pressure gas turbine works on

(a) Stirling Cycle

(b) Atkinson Cycle

(c) Rankine Cycle

(d) Brayton Cycle

**110.** In hydraulic turbines, if the energy available at inlet is only kinetic energy, then that type of turbine is

(a) Reaction turbine

(b) Impulse turbine

(c) Francis turbine

(d) Kaplan turbine

**111.** A centrifugal pump has an impeller of 30 cm outer diameter. The vane tips are radial at the outlet. For a rotative speed of 1450 rpm, what is the manometric head developed? (Assume a manometric efficiency of 82% and take $g = 9.81$ m/s²)

(a) 37·24 m

(b) 43·38 m

(c) 29·46 m

(d) 32·88 m

**112.** Lenoir cycle is used for

(a) Gas turbines

(b) Pulse jet engines

(c) S.I. engines

(d) C.I. engines

**113.** A diesel engine has a compression ratio of 20 and cut-off takes place at 5% of the stroke. What is the cut-off ratio?

(a) 1·21

(b) 1·47

(c) 1·73

(d) 1·95

**114.** The cubic capacity of a four-stroke over-square spark-ignition engine is 275 cc. The clearance volume is 25 cc. What is the compression ratio of the engine?

(a) 8

(b) 10

(c) 12

(d) 14

**115.** The mechanical efficiency of a single-cylinder four-stroke engine is 60%. The frictional power is estimated to be 30 kW. What is the indicated power?

(a) 120 kW

(b) 75 kW

(c) 150 kW

(d) 130 kW

**116.** A four-stroke petrol engine at full load delivers 100 kW. It requires 10 kW to rotate it without load at same speed. What is the mechanical efficiency at half load?

(a) 67·82%

(b) 70·24%

(c) 77·32%

(d) 83·33%

**117.** Freon-12 is used in a simple saturation cycle, with suction saturation temperature of –10°C and condensing saturation temperature of 30°C. If the clearance volume is 6% of the stroke volume, what is the volumetric efficiency? (Consider specific volume at suction and discharge to be 0·07815 m³/kg and 0·025 m³/kg respectively)

(a) 87·24%

(b) 71·31%

(c) 64·85%

(d) 55·43%

**118.** Relative ozone destruction efficiency of R-12 is

(a) 0·29

(b) 0·86

(c) 0·05

(d) 0·57

**119.** An air cooled condenser has 6 m² of surface with a removal of 50 kJ.hr⁻¹.m⁻².°C⁻¹. What is the refrigerant temperature to dissipate 5235 kJ/hr, if the room temperature is 25°C?

(a) 24·31°C

(b) 35·82°C

(c) 42·45°C

(d) 56·94°C

**120.** The actual and theoretical COP of rolling piston compressor are 3·6 and 4·7 respectively. What is the relative COP?

(a) 8·3

(b) 16·92

(c) 1·3

(d) 0·76

**121.** A fuel consists of 92% carbon, 7% hydrogen and remaining residual matter by mass. Working from first principles, the higher calorific value of the fuel is

(a) 40176 kJ/kg
(b) 41176 kJ/kg
(c) 40876 kJ/kg
(d) 41678 kJ/kg

**122.** In order to burn a fuel completely, which of the following basic conditions must be fulfilled?

1. Supply enough air for complete combustion of fuel.
2. Secure low turbulence for thorough mixing of fuel and air.
3. Maintain a furnace temperature high enough to ignite the incoming fuel air mixture.
4. Provide a furnace volume large enough to allow time for combustion to be completed.

Select the correct answer using the code given below:

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

**123.** The efficiency of any cycle increases with

(a) the decrease of maximum pressure and the constant of exhaust pressure.
(b) the decrease of maximum pressure and the decrease of exhaust pressure.
(c) the increase of maximum pressure and the decrease of exhaust pressure.
(d) the increase of maximum pressure and the constant of exhaust pressure.

FGT-B-MCH                    (20 – C)

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**124.** In a power plant, the efficiencies of the electric generator, turbine (mechanical), boiler, cycle and the overall plant are 0·97, 0·95, 0·92, 0·42 and 0·33, respectively. What is the efficiency of auxiliaries?

(a) 98·14%
(b) 92·68%
(c) 83·41%
(d) 75·14%

**125.** Consider the following statements for analysis of steam cycles:

1. A steam power plant continuously converts the energy stored in fossil fuels or fissile fuels into shaft work.
2. Steam power plants work on Brayton cycle.
3. In supercritical steam cycle, steam is generated in a 'once-through' boiler at a pressure above the critical point of 27·5 bar.
4. Deaerator is used for the purpose of deaerating the feedwater.

Which of the above statements are correct?

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

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**126.** Consider the following statements for solid fuels:

1. Peat is the first stage in the formation of coal from wood.
2. The average calorific value of bituminous coal is 1524 kJ/kg.
3. Anthracite is very hard coal and has a shining black lustre.
4. Wood charcoal is obtained by destructive distillation of wood.

Which of the above statements are correct?

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

**127.** Consider the following statements for fluidized bed boilers:

1. Fluidized bed boilers produce steam from fossil fuels and waste fuels by using a technique called fluidized bed combustion.
2. Cyclone separators are gas cleaning devices that utilize the centrifugal force created by a spinning gas stream to separate particles from a gas.
3. In a pressurized fluidized bed boiler, the combustion process takes place in a pressurized environment resulting in a compact furnace and improved combustion efficiency.

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

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**128.** Consider the following statements for steam turbines:

1. The ratio of actual enthalpy drop to isentropic enthalpy drop is known as mechanical efficiency.
2. The ratio of enthalpy drop in moving blades to enthalpy drop in the stage is known as degree of reaction.
3. Rateau turbine is the example of reaction turbine.
4. Curtis turbine is the example of impulse turbine.

Which of the above statements are correct?

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

**129.** Consider the following statements for cooling towers:

1. Cooling tower is an artificial device used to cool the hot cooling water coming out of condenser more effectively.
2. The amount of water usually lost with induced draft cooling tower ranges from 5% to 6% by evaporation.
3. The amount of water usually lost with induced draft cooling tower ranges from 7% to 8% by drift losses.
4. The rate of evaporation of water and its cooling effect on the remaining water depends upon the relative humidity of air passing through the tower.

Which of the above statements are correct?

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

FGT-B-MCH                    (21 – C)

**130.** A single-acting reciprocating pump, running at 50 rpm delivers 0·00736 m³/s of water. The diameter of the piston is 200 mm and stroke length is 300 mm. What is the percentage slip of the pump ?

(a) 5·29%

(b) 6·29%

(c) 7·29%

(d) 8·29%

**131.** A pump discharges a liquid into a tank at the rate of 0·032 m³/s. The tank, 1·5 m in diameter and 4·20 m in height, can hold 3500 kg of liquid. The density of the liquid and mass flow rate of the liquid handled by the pump are respectively,

(a) 471·57 kg/m³ and 16 kg/s

(b) 471·57 kg/m³ and 15 kg/s

(c) 481·57 kg/m³ and 16 kg/s

(d) 481·57 kg/m³ and 15 kg/s

**132.** In Francis turbine, as the water discharge is radial at the outlet, the velocity whirl at the outlet becomes

(a) 1

(b) 0

(c) ∞

(d) 0·5

**133.** A pump impeller is 375 mm in diameter and it discharges water with velocity components of 2 m/s and 12 m/s in the radial and tangential directions respectively. The impeller is surrounded by a concentric cylindrical chamber with parallel sides, the outer diameter being 450 mm. If the flow in the chamber is a free spiral vortex, what are the tangential velocity and radial velocity at the outlet of the chamber respectively ?

(a) 12 m/s and 1·67 m/s

(b) 10 m/s and 1·67 m/s

(c) 12 m/s and 1·76 m/s

(d) 10 m/s and 1·76 m/s

**134.** Which one of the following types of impellers is used to handle highly solid-laden liquids like concrete and slurry ?

(a) Fully Open Impeller

(b) Semi-Enclosed Impeller

(c) Fully-Enclosed Impeller

(d) Quarter Open Impeller

**135.** In a single reciprocating pump without air vessel, the ratio of the average frictional head to the maximum frictional head in the delivery pipe is

(a) 1/2

(b) 1/3

(c) 2/3

(d) 3/4

**136.** In various solar energy storage systems, pumped hydro-electric storage system falls under which one of the following categories ?

(a) Thermal energy storage

(b) Electrical energy storage

(c) Mechanical energy storage

(d) Electromagnetic energy storage

**137.** What is the standard value of solar constant adopted by World Radiation Centre ?

(a) 1192 W/m²

(b) 1084 W/m²

(c) 1927 W/m²

(d) 1367 W/m²

**138.** What is the tip speed ratio of savonius wind turbine rotor ?

(a) 1

(b) 3

(c) 5

(d) 7

**139.** What is the solidity of American multiblade wind turbine rotor ?

(a) 0·4

(b) 0·7

(c) 0·9

(d) 1

**140.** The energy density of Bio-ethanol is

(a) 8·3 MJ/kg

(b) 14·6 MJ/kg

(c) 26·9 MJ/kg

(d) 34·7 MJ/kg

**141.** The percentage of hydrogen in producer gas is

(a) 34%

(b) 27%

(c) 19%

(d) 8%

**142.** In single basin, double effect scheme, power is generated

(a) during filling.

(b) during emptying.

(c) on ebb only.

(d) on both flood and ebb.

**143.** The operating temperature of alkaline fuel cell is

(a) 39°C

(b) 90°C

(c) 127°C

(d) 192°C

**144.** The ideal emf produced by polymer electrolyte membrane fuel cell at 25°C is

(a) 3·57 V

(b) 2·94 V

(c) 1·23 V

(d) 0·73 V

**145.** Which one of the following fuel cells has highest efficiency ?

(a) PAFC

(b) MCFC

(c) PEMFC

(d) AFC

**146.** How many kilograms of steam per day is produced by 15 m diameter community solar cooker developed by Centre for Scientific Research, Auroville (Puducherry) ?

(a)  100 kg

(b)  300 kg

(c)  600 kg

(d)  1000 kg

**147.** In a solar passive space heating system, the south-facing thick wall is called

(a)  Vent wall

(b)  Trombe wall

(c)  Damper wall

(d)  Ventilation wall

**148.** All power plants use superheated steam due to which of the following advantages ?

1.  Superheating is mostly done from waste heat of boiler without additional cost of fuel.

2.  The plant efficiency increases due to higher temperature of steam.

3.  There is less corrosion and erosion of equipment due to absence of moisture in the steam.

Select the correct answer using the code given below :

(a)  1 and 2 only

(b)  2 and 3 only

(c)  1 and 3 only

(d)  1, 2 and 3

**149.** What are the effects of regenerative feedwater heating for the same turbine output ?

1.  It significantly increases the cycle efficiency and reduces the heat rate.

2.  It increases the steam flow rate.

3.  It increases the steam flow to the condenser.

4.  If there is no change of boiler output, the turbine output drops.

Select the correct answer using the code given below :

(a)  1, 2 and 3 only

(b)  1, 2 and 4 only

(c)  1, 3 and 4 only

(d)  2, 3 and 4 only

**150.** Which of the following are the advantages of pulverized coal firing ?

1.  Higher boiler efficiency.

2.  Fast response for no load changes.

3.  Ability to use low preheated air reducing internal losses.

4.  Ability to release large amounts of heat enabling it to generate about 2000 t/h of steam in one boiler.

Select the correct answer using the code given below :

(a)  1 and 2 only

(b)  1 and 3 only

(c)  1 and 4 only

(d)  2, 3 and 4 only

FGT-B-MCH                                ( 24 – C )