Serial No.

QUESTION BOOKLET

A

41957

GENERAL ENGINEERING (04)

Time Allowed : 3 Hours

[1 Hour for Objective

2 Hours for Subjective]

Maximum Marks : 200

[100 Marks for Objective

100 Marks for Subjective]

INSTRUCTIONS FOR CANDIDATES

1. This Question Booklet consists of **two** Parts (Objective and Subjective). Candidate has to attempt both the Parts.

2. **In Objective Part, there are 50 questions carrying 2 marks each. There is no negative marking for any wrong answer. In Subjective Part, four (4) questions should be answered in which Question No. 1 is compulsory.**

3. Please do not open this Question Booklet until you are told to do so.

4. Candidate must fill up the necessary information in the space provided on the OMR Answer Sheet before commencement of the test.

5. For marking the correct answer, darken one circle by **black or blue** ball-point pen only. Please do not mark on more than one circle. Darkening on more than one circle against an answer will be treated as wrong answer.

6. Do not detach any leaf from this Question Booklet. After the examination, hand over the OMR Answer Sheet to the Room Invigilator.

7. Possession and use of Calculator, Mobile Phone and Pager is prohibited in the Examination Hall.

8. Candidates are informed that evaluation of OMR Sheets will be done by Electronic Machine. So, they should shadow the bubbles of Roll No., Booklet Series and Booklet No. properly, otherwise Machine will not be able to evaluate it. Failure to comply this instruction will be sole responsibility of the candidates.

(Objective)

1. The minimum coefficient of friction between a sphere and an inclined plane of θ, so that the sphere may roll without slipping is

   (A) $\tan\theta$ (B) $\frac{1}{2}\tan\theta$

   (C) $\frac{2}{7}\tan\theta$ (D) $\frac{1}{7}\tan\theta$

2. If a ball which is dropped from a height of 2·25 m on a smooth floor attains the height of bounce equal to 1·00 m, the coefficient of the restitution between the ball and the floor is equal to

   (A) 0·25

   (B) 0·50

   (C) 0·67

   (D) 0·33

3. Horizontal range of a projectile fired with initial velocity u at angle α to horizontal is equal to

   (A) $\dfrac{u^2\sin 2\alpha}{g}$

   (B) $\dfrac{u^2\cos 2\alpha}{g}$

   (C) $\dfrac{u^2\cos\alpha}{g}$

   (D) $\dfrac{u^2\sin\alpha}{g}$

4. The steel bar *ABCD* of varying sections is subjected to the axial forces as shown in the figure below. Find the value of *P* necessary for equilibrium. If $E = 210$ kN/mm^2, determine the total elongation of the bar
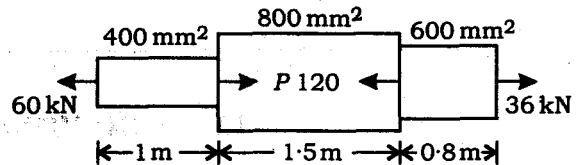
   (A) $P = 74$ kN; 2·01 mm

   (B) $P = 84$ kN; 1·11 mm

   (C) $P = 94$ kN; 3·17 mm

   (D) $P = 104$ kN; 0·01 mm

5. The shape of a cantilever for uniformly distributed load will be

   (A) straight line

   (B) parabolic

   (C) elliptical

   (D) None of the above

6. According to Euler's formula, the buckling load ρ for a column of length l with both ends hinged and having I = least moment of inertia of the section of the column, and E = modulus of the elasticity of the material of the column, is

(A) $\rho = \dfrac{2\pi^2 EI}{l}$ (B) $\rho = \dfrac{\pi^2 EI}{4l^2}$

(C) $\rho = \dfrac{\pi^2 EI}{l^2}$ (D) $\rho = \dfrac{4\pi^2 EI}{l^2}$

7. Maximum shear stress in a Mohr's circle is

(A) equal to radius of Mohr's circle

(B) greater than the radius of Mohr's circle

(C) less than the radius of Mohr's circle

(D) Could be any of the above

8. A boiler shell 200 cm diameter and plate thickness 1·5 cm is subjected to internal pressure of $1·5 \, MN/m^2$, then the hoop stress will be

(A) $30 \, MN/m^2$

(B) $50 \, MN/m^2$

(C) $100 \, MN/m^2$

(D) $200 \, MN/m^2$

9. The deformation of a bar under its own weight compared to the deformation of same body subjected to a direct load equal to weight of the body is

(A) same

(B) double

(C) half

(D) four times

10. Two solid shafts are made of same material and have their diameters D and $D/2$. The ratio of the strength of bigger shaft to smaller one in torsion is

(A) 4

(B) 2

(C) 8

(D) 16

11. In case of pure shear at a point, the sum of normal stresses on two orthogonal planes is equal to

(A) maximum shear stress

(B) twice the maximum shear stress

(C) half the maximum shear stress

(D) zero

12. For an irreversible process, entropy change is

(A) greater than $\dfrac{\delta Q}{T}$

(B) equal to $\dfrac{\delta Q}{T}$

(C) less than $\dfrac{\delta Q}{T}$

(D) equal to zero

13. To reduce the possibility of knock in the CI engines, the first elements of fuel and air should have

(A) high temperature

(B) high density

(C) short delay

(D) All of the above

14. In impulse-reaction turbines, the pressure drops

(A) in fixed nozzles

(B) in moving blades

(C) in fixed blades

(D) in both fixed and moving blades

15. Absorptivity of a body will be equal to its emissivity

(A) at all temperatures

(B) at one particular temperature

(C) when the system is under thermal equilibrium

(D) at critical temperature

16. In order to increase sensitivity of U-tube manometer, one leg is usually inclined by angle θ. Sensitivity of inclined tube to sensitivity of U-tube is equal to

(A) $\sin\theta$

(B) $\dfrac{1}{\sin\theta}$

(C) $\cos\theta$

(D) $\dfrac{1}{\cos\theta}$

17. To avoid cavitation in centrifugal pumps

(A) suction pressure should be low

(B) delivery pressure should be low

(C) suction pressure should be high

(D) delivery pressure should be high

18. Heat transferred to a system at constant pressure is equal to

(A) work transfer

(B) change in internal energy

(C) change in enthalpy

(D) change in entropy

19. What is the basic equation of thermal radiation from which all other equations of radiation can be derived?

(A) Stefan-Boltzmann equation

(B) Planck's equation

(C) Wein's equation

(D) Rayleigh-Jeans formula

20. An insulated box containing 0·5 kg of a gas having $C_V = 0·98$ kJ/kg-K falls from a balloon 4 km above the earth's surface. The temperature rise of the gas when the box hits the ground is

(A) 0 K

(B) 20 K

(C) 40 K

(D) 60 K

21. For the flow over a flat plate, the hydrodynamic boundary layer thickness is 0·5 mm. The dynamic viscosity is 25×10^{-6} Pa-s, specific heat is 2·0 kJ/kg-K and thermal conductivity is 0·05 W/m-K. The thermal boundary layer thickness would be

(A) 0·1 mm

(B) 0·5 mm

(C) 1 mm

(D) 2 mm

22. Match List–I with List–II and select the correct answer using the code given below the Lists :

List–I	*List–II*
a. Reynolds number	1. Film coeff., pipe diameter, thermal conductivity
b. Prandtl number	2. Flow velocity, acoustic velocity
c. Nusselt number	3. Heat capacity, dynamic viscosity, thermal conductivity
d. Mach number	4. Flow velocity, pipe diameter, kinematic viscosity

Code :

	a	b	c	d
(A)	4	1	3	2
(B)	4	3	1	2
(C)	2	3	1	4
(D)	2	1	3	4

23. The equation of a velocity distribution over a plate is given by $u = 2y - y^2$, where u is the velocity in m/s at a point y meter from the plate measured perpendicularly. Assuming, $\mu = 8·60$ poise, the shear stress at a point 15 cm from the boundary is

(A) 1·72 N/m^2

(B) 1·46 N/m^2

(C) 14·62 N/m^2

(D) 17·20 N/m^2

24. For turbulent boundary layer flow, the thickness of laminar sublayer δ is given by

(A) $\dfrac{v}{u^*}$

(B) $5\left(\dfrac{v}{u^*}\right)$

(C) $5 \cdot 75\log\left(\dfrac{v}{u^*}\right)$

(D) $2300\left(\dfrac{v}{u^*}\right)$

25. In a fully turbulent flow through a rough pipe, the friction factor f is (Re is the Reynolds number and k/D is relative roughness)

(A) a function of Re

(B) a function of Re and k/D

(C) a function of k/D

(D) independent of Re and k/D

26. Power dissipated in a pure capacitor is

(A) minimum

(B) maximum

(C) infinite

(D) zero

27. High current of the order of 100 A can be measured by an ammeter of 0–1 A rating by using

(A) shunt

(B) capacitor

(C) R-C network

(D) current transformer

28. The torque developed by an induction motor corresponding to zero-slip is equal to

(A) maximum

(B) full-rated capacity

(C) zero

(D) minimum

29. Which of the following is zero inside a charged conducting sphere?

(A) Potential

(B) Electric intensity

(C) Both (A) and (B)

(D) None of the above

30. Thevenin resistance R_{th} is found

(A) between any two open terminals

(B) by short-circuiting the given two terminals

(C) by removing voltage sources along with their internal resistances

(D) between same open terminal as for V_{th}

31. Consider the following statements :

Casein glue is

1. obtained from milk
2. obtained from the blood of animals
3. used in painting of metals
4. used in plywood industry
5. white in colour
6. red in colour

Which of the statements given above are correct?

(A) 1, 3 and 5

(B) 1, 4 and 5

(C) 2, 3 and 6

(D) 2, 4 and 6

32. A concrete cylinder of size 15 mm diameter and 300 mm long is tested for split tensile strength of concrete. It failed at a load of 100 kN, the split tensile strength (in N/mm^2) is

(A) 0·35   (B) 0·71

(C) 1·42   (D) 2·83

33. Which of the following aggregates gives maximum strength in concrete?

(A) Rounded aggregate

(B) Elongated aggregate

(C) Flaky aggregate

(D) Cubical aggregate

34. For stones, Mohs scale is used to determine

(A) toughness

(B) hardness

(C) flakiness index

(D) durability

35. Match List–I (constituents of bricks) with List–II (corresponding influence) and select the correct answer using the code given below the Lists :

List–I (Constituents of bricks)	List–II (Corresponding influence)
a. Alumina	1. Colour brick
b. Silica	2. Plasticity recovery for moulding
c. Magnesia	3. Reacts with silica during burning and causes particles to unite together and development of strength
d. Limestone	4. Preserves the form of brick at high temperature and prevent shrinkage

Code :

(A) a b c d
     2 1 4 3

(B) a b c d
     3 4 1 2

(C) a b c d
     2 4 1 3

(D) a b c d
     3 1 4 2

36. Two heaters rated at 1000 W, 250 volts each, are connected in series across a 250 volts, 50 Hz AC mains. The total power drawn from the supply would be

(A) 1000 W

(B) 500 W

(C) 250 W

(D) 2000 W

37. At half-power points of a resonance curve, the current is how much times the maximum current?

(A) 2

(B) $\sqrt{2}$

(C) $1\sqrt{2}$

(D) $1/\sqrt{2}$

38. Select the correct statement :

Dummy activity on a PERT/CPM chart means, it

(A) consumes time, but no resources

(B) consumes resources, but no time

(C) consumes neither time nor resources

(D) consumes both resources and time

39. If a is the optimistic time, b is the pessimistic time and m is most likely time of an activity, then the expected time of activity is

(A) $\dfrac{a+m+b}{6}$

(B) $\dfrac{a+2m+b}{6}$

(C) $\dfrac{a+4m+b}{6}$

(D) $\dfrac{a+5m+b}{6}$

40. Critical path moves along the activities having total float of

(A) positive value

(B) negative value

(C) zero value

(D) same value

41. Which of the following are the guidelines for the construction of a network diagram?

1. Each activity is represented by one and only one arrow in the network.

2. Two activities can be identified by the same beginning and end events.

3. Dangling must be avoided in a network diagram.

4. Dummy activity consumes no time or resource.

Select the correct answer using the code given below :

Code :

(A) 1, 2 and 3

(B) 1, 3 and 4

(C) 1, 2 and 4

(D) 2, 3 and 4

42. Which of the following methods of offsets involves less measurement on the ground?

(A) Method of perpendicular offsets

(B) Method of oblique offsets

(C) Method of ties

(D) All involving equal measurement on the ground

43. Which of the following are the fundamental lines of a theodolite?

1. The vertical and horizontal axes.

2. The diagonally opposite screw lines.

3. The line of collimation and axes of the plate levels.

4. The bubble line of the attitude level.

Select the correct answer using the code given below :

Code :

(A) 1, 2 and 3

(B) 1, 2 and 4

(C) 2 and 3

(D) 1, 3 and 4

44. During the chaining along a straight line, the leader of the party has 4 arrows in his hand while the follower has 6. Distance of the follower from the starting point is

(A) 4 chains

(B) 6 chains

(C) 120 m

(D) 180 m

45. Height of the instrument method of levelling is

(A) more accurate than rise and fall method

(B) less accurate than rise and fall method

(C) quicker and less tedious for large number of intermediate sights

(D) None of the above

46. Direct method of controlling is

(A) a quick method

(B) adopted for large surveys only

(C) most accurate method

(D) suitable for hilly terrains

47. Which of the following methods of plane table surveying is used to locate the position of an inaccessible points?

(A) Radiation

(B) Intersection

(C) Traversing

(D) Resection

48. Disinfection of water results in

(A) removal of turbidity

(B) removal of hardness

(C) killing of disease bacteria

(D) complete sterilization

49. In water-treatment plant, dissolved iron and manganese can be removed from the water by

(A) aeration

(B) aeration and coagulation

(C) aeration and flocculation

(D) aeration and sedimentation

50. The intensification of greenhouse effect is attributed to the increased level of

(A) carbon dioxide

(B) carbon monoxide

(C) chlorofluorocarbon

(D) sulphur dioxide

★★★

GENERAL ENGINEERING (04)

PART—B

(Subjective)

Full Marks : 100   *Time* : 2 hours

The figures in the margin indicate full marks for the questions

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

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

   (a) Distinguish between whole-circle bearing and reduced bearing.
   Convert the following reduced bearings to whole-circle bearings :

   (i) S 5° 15′ W

   (ii) N 45° 06′ E

   (iii) S 44° 08′ E

   (iv) N 57° 51′ W

   (b) Explain the principle of working of hot-wire anemometer.

   (c) A bar is subjected to two unequal-like principal stresses P_1 and P_2.
   Explain the method of Mohr's circle of stresses for this case with neat
   sketch.

   (d) Compare between the network techniques CPM and PERT in brief.

   (e) Explain the construction and functioning of Pitot static probe.

   (f) An electric cable of 12 mm in diameter is insulated for carrying the
   maximum current. The cable surface temperature should not exceed
   70 °C either the cable is bare or insulated. Assume the following data :

   > Surrounding air temperature (T_a) = 20 °C
   >
   > Heat-transfer coefficient on the surface of bare or insulated
   >   wire (h_t) = 10 W/m^2-K
   >
   > Conductivity of insulating material = 0·16 W/m^2-K

   Find the maximum possible percentage increase in current-carrying
   capacity of the cable by providing the insulation.

(g) Explain how 'thermodynamics' and 'heat transfer' disciplines are different.

(h) With the help of h-s diagram, for 1 kg of superheated steam, obtain the efficiency of ideal Rankine cycle and show how the pump work can be determined to obtain the efficiency of this cycle.

2. (a) A uniform ladder 3 m long and weighing 200 N is placed against a wall making an angle of 60° with the ground. The ladder, in addition to its own weight, has to support an 800 N weight of a man standing at its upper end. Presuming that coefficient of friction between the wall and ladder is 0·3 and that between the ground and ladder is 0·4, calculate the horizontal force P to be applied at the ground level to prevent slipping. If the force P is not applied, what should be the minimum inclination of the ladder with the horizontal so that there is no slipping of it with the man standing its upper end? 10

(b) A hammer of mass 200 kg is made to fall freely from 2 m height on the head of a pile of 1500 kg mass. The pile is driven 5 cm into the ground in one blow. Determine—

(i) the common velocity of the pile and hammer after the impact;

(ii) the energy lost in the impact;

(iii) the average resistance of the ground to penetration. 15

3. (a) A metal bar of 10 mm diameter when subjected to a pull of 23·55 kN gave an elongation of 0·3 mm on a gauge length of 200 mm. In a torsion test on the same material, a maximum shear stress of 40·71 N/mm^2 was measured on bar of 50 mm diameter. The angle of twist measured over a length of 300 mm was 0 deg minute. Determine Poisson's ratio of the material. 10

(b) A beam ABC of length L is simply supported at one end A and at end B distance x from the free end C. The beam carries a UDL of intensity w per unit length over its entire length. Determine the value of x so that the distribution of bending moment in the span will be most economical. 15

4. (a) Water is flowing from a garden hose. A child places his thumb to cover most of the hose outlet, causing a thin jet of high-speed water to emerge. The pressure in the hose just upstream of his thumb is 400 kPa. If the hose is held upward, find the maximum height that the jet could achieve. State the assumptions made to apply the equation. 10

(b) Water at 15 °C ($\rho = 999$ kg/m^3 and $\mu = 1{\cdot}138 \times 10^{-3}$ kg/m-s) is flowing steadily in a 5 cm diameter horizontal pipe made of stainless steel at a rate of 0·006 m^3/s. Determine the pressure drop, the head loss and the required pumping power input for flow over a 60 m long section of pipe.   15
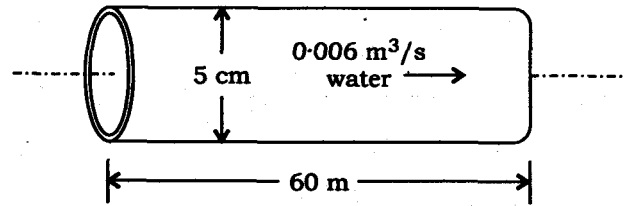
5. (a) Air at 20 °C enters a circular pipe 16 cm in diameter and 160 cm long whose wall is maintained at 160 °C. How much heat is transferred? Assume the flow is turbulent and same heat-transfer coefficient throughout.

Average velocity of air = 15 m/sec

Use Reynolds analogy and take the following properties at average temperature of air 90 °C :   10

$$v = 22 \times 10^{-6} \text{ m}^2/\text{sec}, \quad K = 0{\cdot}027 \text{ W/m-K}$$

(b) If the velocity distribution in the boundary layer of a flat plate is given by an expression

$$\frac{u}{U} = \sin \frac{\pi}{2}\left(\frac{y}{\delta}\right)$$

then find the expression for the boundary layer thickness.   15

6. (a) During a certain expansion process of a perfect gas, the variation in pressure is estimated to conform to the linear relation $p = aV + b$, where a and b are constants and V represents the volume in m^3. The gas has a mass of 0·75 kg, the initial and final pressures are 4 bars and 2 bars and the corresponding volumes are 0·1 m^3 and 0·2 m^3. Calculate the work and heat interactions during the process and comment on the nature of the process.   10

(b) What do you understand by the heat engines and reversed heat engines? Three Carnot engines E_1, E_2 and E_3 operate between temperatures of 1000 K and 3000 K. Calculate their intermediate temperatures, if the work produced by the engines are in the ratio of 4 : 3 : 2.   15

7. *(a)* Prepare a table of independent, free and total float for the network in the following figure. Number written on the arrows shows the duration of that activity. Show the critical path of the network by dark arrows.   15
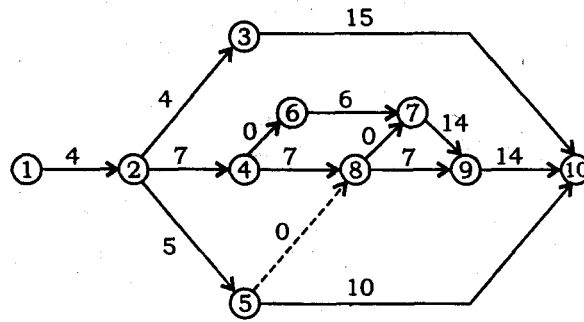
(b) The inter-dependence of a job consisting of seven activities *A* to *G* is given as :

Activity	:	*A*	*B*	*C*	*D*	*E*	*F*	*G*
Predecessor Activity	:	—	—	*A*	*B*	*A*	*B*	*C, D*
Succeeding Activity	:	*C, E*	*D, F*	*G*	*G*	—	—	—

The time estimates, in days, for each activity are :

Activity	Time Estimates
A	6–9–18
B	5–8–17
C	4–7–22
D	4–7–16
E	4–7–10
F	2–5–7
G	4–10–22

Z(+)	% Probability
0·8	78·81
0·9	81·59
1·0	84·13
1·1	86·43
1·2	88·49

Draw the network and determine the probability of completing the job in 35 days.   10

★ ★ ★