

Date : October 9, 2022
Total Marks : 100
Writing Time : 150 minutes (2.5 hours)
Reading Time : 15 Minutes (prior to writing time)

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:
 - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions
 Part II - 4 Short Answer Questions

All questions under SECTION A are **COMPULSORY**.
 - **SECTION B** consists of two Case Studies. Choose only **ONE** case study and answer the questions of your choice.
4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.
6. Begin each Section and Part in a fresh page of the Answer Booklet.
7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
8. Use of any other paper including paper for rough work is not permitted.
9. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
10. This paper has **8 printed pages**, including this instruction page.

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SECTION A

PART I: Multiple Choice Questions [30 marks]

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. Two balls of equal mass and of perfectly elastic material are lying on the floor. One of the balls with velocity “v” is made to struck the second ball. Both the balls after impact will move with a velocity:
 - a) v
 - b) $\frac{v}{2}$
 - c) $\frac{v}{4}$
 - d) $\frac{v}{8}$
2. The velocity ratio in case of an inclined plane inclined at an angle θ to the horizontal and weight being pulled up the inclined plane by vertical effort is:
 - a) $\sin \theta$
 - b) $\cos \theta$
 - c) $\tan \theta$
 - d) $\operatorname{cosec} \theta$
3. If the resultant of two equal forces has the same magnitude as either of the forces, then the angle between the two forces is:
 - a) 30°
 - b) 60°
 - c) 90°
 - d) 120°
4. Moment of inertia of a circular section about an axis perpendicular to the section is:
 - a) $\frac{\pi d^3}{16}$
 - b) $\frac{\pi d^3}{32}$
 - c) $\frac{\pi d^4}{32}$
 - d) $\frac{\pi d^4}{64}$

5. The time of flight (t) of a projectile on an upward inclined plane is (where u = Velocity of projection, α = Angle of projection, and β = Inclination of the plane with the horizontal):

a) $t = \frac{g \cos \beta}{2u \sin(\alpha - \beta)}$

b) $t = \frac{2u \sin(\alpha - \beta)}{g \cos \beta}$

c) $t = \frac{g \cos \beta}{2u \sin(\alpha + \beta)}$

d) $t = \frac{2u \sin(\alpha + \beta)}{g \cos \beta}$

6. The unit of angular acceleration is:

- a) N-m
- b) m/s
- c) m/s²
- d) rad/s²

7. _____ is determined based on the value of bulk modulus of a fluid.

- a) Reynold's number
- b) Froude's number
- c) Mach number
- d) Euler's number

8. Kinematic viscosity is the

- a) ratio of absolute viscosity to the density of the liquid.
- b) ratio of density of the liquid to the absolute viscosity.
- c) product of absolute viscosity and density of the liquid.
- d) product of absolute viscosity and mass of the liquid.

9. The diameter of the nozzle (d) for maximum transmission of power is given by (where D = Diameter of pipe, f = Darcy 's coefficient of friction for pipe, and l = Length of pipe):

a) $d = \sqrt{\frac{D^5}{8fl}}$

b) $d = \sqrt[3]{\frac{D^5}{8fl}}$

c) $d = \sqrt[4]{\frac{D^5}{8fl}}$

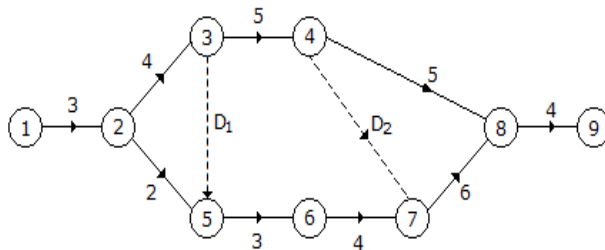
d) $d = \sqrt[5]{\frac{D^5}{8fl}}$

10. Coefficient of contraction is the ratio of
- a) actual velocity of jet at vena contracta to the theoretical velocity.
 - b) loss of head in the orifice to the head of water available at the exit of the orifice.
 - c) actual discharge through an orifice to the theoretical discharge.
 - d) area of jet at vena contracta to the area of orifice.
11. The loss of head due to friction in a pipe of uniform diameter in which a viscous flow is taking place, is (where R_N = Reynold number):
- a) $\frac{1}{R_N}$
 - b) $\frac{4}{R_N}$
 - c) $\frac{16}{R_N}$
 - d) $\frac{64}{R_N}$
12. A cycle consisting of two isothermal and two isentropic processes, is known as:
- a) Carnot cycle
 - b) Stirling cycle
 - c) Ericsson cycle
 - d) Joule cycle
13. The amount of heat required to raise the temperature of _____ of water through one degree is called kilojoule.
- a) 1 g
 - b) 10 g
 - c) 100 g
 - d) 1000 g
14. A turbine is said to have an axial discharge when the steam leaves the blade tip at _____ to the direction of the blade motion.
- a) 60°
 - b) 90°
 - c) 180°
 - d) 270°
15. In a four stroke cycle, the minimum temperature inside the engine cylinder occurs at
- a) the beginning of suction stroke.
 - b) the end of suction stroke.
 - c) the beginning of exhaust stroke.
 - d) the end of exhaust stroke.

16. In summer air-conditioning, the air is
- cooled and humidified.
 - cooled and dehumidified.
 - heated and humidified.
 - heated and dehumidified.
17. In a four stroke cycle petrol engine, the charge is ignited at
- 30° before top dead centre.
 - 30° after top dead centre.
 - 30° before bottom dead centre.
 - 30° after bottom dead centre.
18. Moderator in nuclear power plants, is a medium introduced into the fuel mass in order to
- slow down the speed of fast-moving neutrons.
 - control the reaction.
 - reduce the temperature.
 - extract heat from nuclear reaction.
19. _____ of rotary compressor is used in aeroplanes.
- Centrifugal type
 - Axial flow type
 - Radial flow type
 - Centripetal type
20. If T_1 is the temperature at which the working substance receives heat, T_2 is the temperature of cooling water and T_3 is the evaporator temperature, the C.O.P of an absorption type refrigerator is given by:
- $$\frac{T_1(T_2 - T_3)}{T_3(T_1 - T_2)}$$
 - $$\frac{T_3(T_1 - T_2)}{T_1(T_2 - T_3)}$$
 - $$\frac{T_1(T_1 - T_2)}{T_3(T_3 - T_2)}$$
 - $$\frac{T_2(T_1 - T_3)}{T_3(T_1 - T_2)}$$
21. _____ states that the heat transfer from a hot body to a cold body is directly proportional to the surface area and difference of temperatures between the two bodies.
- First law of thermodynamics
 - Newton's law of cooling
 - Newton's law of heating
 - Stefan's law

22. Segmental chips are formed during machining of _____.
- mild steel
 - cast iron
 - high speed steel
 - high carbon steel
23. To drill a through-hole in a mild steel plate of 20 mm thick using $\phi 20$ mm drill bit rotating at 500 RPM with a feed of 0.2 mm/revolution, the depth of cut required is:
- 0.2 mm
 - 10 mm
 - 20 mm
 - 100 mm

24. In the following network diagram, critical path is along _____.



- 1-2-3-4-8-9
 - 1-2-3-5-6-7-8-9
 - 1-2-3-4-7-8-9
 - 1-2-5-6-7-8-9
25. _____ is mainly used with locomotive and marine boilers.
- Lever safety valve
 - Dead weight safety valve
 - High steam and low water safety valve
 - Spring loaded safety valve
26. A flywheel
- converts reciprocating motion of the piston into rotary motion.
 - converts rotary motion of the crankshaft into to and fro motion of the valve rod.
 - prevents fluctuation of speed.
 - maintains engine speed uniform at all load conditions.
27. Ball bearings are usually made from
- low carbon steel.
 - high carbon steel.
 - medium carbon steel.
 - high speed steel.

28. When a body moves with simple harmonic motion, the product of its periodic time and frequency is equal to:
- zero
 - one
 - $\frac{\pi}{2}$
 - π
29. _____ is used to check the accuracy of micrometers, calipers and dial indicators.
- Feeler gauge
 - Slip gauge
 - Ring gauge
 - Plug gauge
30. In summer air-conditioning, the air is
- cooled and humidified.
 - cooled and dehumidified.
 - heated and humidified.
 - heated and dehumidified.

PART II – Short Answer Questions [20 marks]

This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks. Mark for each sub-question is indicated in the brackets.

- Each wheel of a motorcycle is of 600mm diameter and has a moment of inertia of 1.2 Kg.m². The total mass of the motorcycle and the rider is 180Kg and the combined centre of mass is 580mm above the ground level when the motorcycle is upright. The moment of inertia of the rotating parts of the engine is 0.2 kg.m². The engine speed is 5 times the speed of wheels and is in the same sense. Determine the angle of heel necessary when the motorcycle takes a turn of 35 metre radius at the speed of 54 kilometer per hour. **(5 marks)**
- What are the four classes of cam according to the motion of followers? Draw follower displacement-cam angle motion diagram for each class. **(5 marks)**
- In Computer Numerical Control (CNC) machines programming:
 - What are G-Codes and M-Codes in programming? **(1 Mark)**
 - List four G-Codes and describe their functions. **(2 Marks)**
 - List four M-Codes and describe their functions. **(2 Marks)**
- A duct of 15 metre length passes air at the rate of 90 m³/min. Calculate the pressure drop in the duct in millimeters of water when:
 - The duct is of circular cross-section of 300 metre diameter. **(2.5 Marks)**
 - The duct is of 300 millimeter square cross-section. **(2.5 Marks)***(Assume a friction factor of 0.005)*

SECTION B: Case Study [50 marks]

Choose either CASE I OR CASE II from this section. Each case study carries 50 marks.

CASE I

Answer the following questions.

1. Define Reverse Engineering and how is it different from traditional engineering? **(5 marks)**
2. Describe the purpose of reverse engineering. **(5 marks)**
3. Explain reverse engineering process in detail with appropriate flow chart. **(10 marks)**
4. Describe the technology and resources required to adopt reverse engineering in the field of manufacturing. **(5 marks)**
5. What are the legal and ethical challenges pertaining to reverse-engineering? **(5 marks)**
6. What are the advantages and disadvantages of reverse engineering? **(5 marks)**
7. Describe three applications of reverse engineering with detailed explanation of the processes applied. **(15 marks)**

CASE II

Industry 4.0 is considered as a new phase in the Industrial Revolution that strongly focuses on interconnectivity, automation, machine learning, and real-time data. The industrial internet of things (IIoT) and smart manufacturing which are crucial components of Industry 4.0 marries physical production and operations with smart digital technology, machine learning, and big data to create a more holistic and better-connected ecosystem for companies that focus on manufacturing and supply chain management. In order to survive and thrive, companies have realized the crucial importance of investing in Industry 4.0. Mechanical engineering is one of the main professions responsible in taking these technological advancements forward.

In view of the above, provide an in-depth description of the following with relevant facts and figures.

1. Evolution of Industry from 1.0 to 4.0. **(10 marks)**
2. Industrial Internet of Things (IIoT). **(10 marks)**
3. How Smart Manufacturing is different from traditional manufacturing? **(10 marks)**
4. Relevant sectors to adopt Industry 4.0 with justifications. **(10 marks)**
5. Benefits of adopting an Industry 4.0 Model. **(5 marks)**
6. What are the Challenges and how to overcome it to adopt Industry 4.0. **(5 marks)**

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