

2005

28/7

9.30

14/1

MECHANICAL ENGINEERING

Paper 1

Time : 3 Hours ]

[ Maximum Marks : 300

INSTRUCTIONS

Candidates should attempt **all** the questions in Parts A, B & C. However, they have to choose only **three** questions in Part D. The number of marks carried by each question is indicated at the end of the question.

Answers must be written in English.

This paper has four parts :

- |          |           |
|----------|-----------|
| <b>A</b> | 20 marks  |
| <b>B</b> | 100 marks |
| <b>C</b> | 90 marks  |
| <b>D</b> | 90 marks  |

Marks allotted to each question are indicated in each part.

**PART A**

4×5=20

*Each question carries 5 marks.*

1. (a) Explain different kinds of Kinematic pairs giving examples for each of them. 5
- (b) Explain 'Analytical' and 'Graphical' methods of balancing of different masses revolving in the same plane. 5
- (c) With a neat sketch explain working principle of EDM process. 5
- (d) Explain steps involved in 'Graphical' and 'Simplex' methods of Linear programming technique. 5

## PART B

10×10=100

*Each question carries 10 marks.*

1. (a) Describe slip of belt. How is it expressed in terms of an equation ? 5  
 (b) Two pulleys; one 450 mm diameter and the other 200 mm diameter are on parallel shafts 1.95 metres apart and are connected by a crossed belt. Find the length of the belt required and angle of contact between belt and each pulley. 5
2. A cantilever shaft 50 mm diameter and 300 mm long has a disc of mass 100 kg at its free end. The Young's modulus for the shaft material is  $200 \text{ GN/m}^2$ . Determine the longitudinal and transverse vibration of the shaft. 10
3. Explain theories of failure given below with equations : 3+3+4  
 (a) Maximum Normal Stress theory  
 (b) Maximum Shear Stress theory  
 (c) Distortion energy theory
4. Explain in detail ECM and Ultrasonic machining. 10
5. With neat sketches explain briefly the features of Jigs and Fixtures. 10
6. Explain features and policy guidelines for ABC analysis as applied to Inventory control. 10
7. Derive specific Eulers equations for sizes of columns having 5+5  
 (a) Round Cross Section  
 (b) Rectangular Cross Section
8. Draw a neat diagram of Mohr's circle and show principal stresses for the given values of 10  
 $\sigma_x = 80 \text{ MPa}$ ,  $\tau_{xy} = 50 \text{ MPa}$ ;  $\sigma_y = 0$

9. A Manager of an oil refinery company has to decide upon optimal mix of two blending processes to which inputs and outputs are given per production run.

Process	Input		Output	
	Crude 'A'	Crude 'B'	Gasolene 'X'	Gasolene 'Y'
1	5	3	5	8
2	4	5	4	4

The maximum amount of Crude A and B are 200 units and 150 units respectively. Market's requirement show that atleast 100 units of Gasolene 'X' and 80 units of Gasolene 'Y' must be produced. The profit/production run for processes 1 and 2 are Rs. 3 and Rs. 4 per unit respectively. Formulate the problem as LPP.

10. Derive an equation of motion (vibration) for a forced damped vibration for a single degree of freedom using spring, mass and dashpot system.

10

10

## PART C

6×15=90

Each question carries 15 marks.

1. (a) Draw a neat sketch of Universal or Hooke's joint and show the parts. 5
- (b) Two shafts are connected by a Hooke's joint. The driving shaft rotates at uniform speed of 1200 RPM. Determine the greatest permissible angle between the shaft axes so that the total fluctuation of speed does not exceed 100 RPM. Also calculate max/min speeds of driven shaft. 10
2. Compare the Davis Steering Gear and Ackerman Steering Gear with neat sketches.  $7\frac{1}{2} \times 2 = 15$
3. Explain the following types of gear trains with neat sketches : 5×3=15
  - (a) Simple gear train
  - (b) Compound gear train
  - (c) Epicyclic gear train
4. (a) Write a short note on gyroscope. 5
- (b) What do you understand by Gyroscopic couple ? Derive a formula for its magnitude. 10
5. (a) What do you understand by Kinematic link ? 2
- (b) What are the types of links for transmission of motion ? 3
- (c) Enumerate differences between machine and structure. 3
- (d) Explain three types of constrained motion. 7

6. A company is setting an assembly line to produce 192 units per 8 hour shift. The information regarding work elements in terms of time and immediate predecessor are given below.

Work element	Time (secs)	Immediate predecessor
A	40	None
B	80	A
C	30	D, E, F
D	25	B
E	20	B
F	15	B
G	120	A
H	145	G
I	130	H
J	115	C, I

- (a) What is the desired cycle time ?
- (b) What is the theoretical number of stations ?
- (c) What is the efficiency and balance delay of the solution obtained ?

5+5+5

## PART D

Answer any **three** of the following questions. Each question carries 30 marks.

1. (a) Explain with a neat sketch the constructional features of a centrifugal governor. 15
- (b) Derive an expression to show that height of a governor 'h' is inversely proportional to  $N^2$  in case of WATT Governor. 15
2. (a) Draw a neat sketch of single block or shoe brake and show its different parts. 10
- (b) With a neat sketch explain Rope brake dynamometer and derive an expression for Brake horse power. 20
3. (a) State why P and C control charts are used. What do they signify? State the advantages of a P chart over a  $\bar{X}$  chart. 15
- (b) What do you mean by acceptance sampling? State their usefulness over 100 percent inspection. 15
4. What is meant by measurement by comparison? Outline briefly the principles of working of (i) mechanical (ii) optical, and (iii) pneumatic comparator and discuss briefly their relative merits. 30
5. Maximise  $Z = 12x_1 + 20x_2 + 18x_3 + 40x_4$   
subject to  

$$4x_1 + 9x_2 + 7x_3 + 10x_4 \leq 6000$$

$$x_1 + x_2 + x_3 + x_4 \leq 4000$$

$$x_1, x_2, x_3, x_4 \geq 0$$
 30

2005

## MECHANICAL ENGINEERING

Paper 2

*Time : 3 Hours ]**[ Maximum Marks : 300***INSTRUCTIONS**

*Candidates should attempt **all** the questions in Parts A, B & C. However, they have to choose only **three** questions in Part D. The number of marks carried by each question is indicated at the end of the question.*

*Answers must be written in English.*

*This paper has four parts :*

<b>A</b>	20 marks
<b>B</b>	100 marks
<b>C</b>	90 marks
<b>D</b>	90 marks

*Marks allotted to each question are indicated in each part.*

**PART A**

4×5=20

*Each question carries 5 marks.*

1. (a) Define Entropy. Summarize characteristics of Entropy. 2+3=5
- (b) Explain briefly the following : 5
  - (i) Laminar and Turbulent flows
  - (ii) Uniform and Non-uniform flows
- (c) List out classification of IC engines on various conditions. 5
- (d) What are the characteristics of a good refrigerant ? 5

**PART B**

10×10=100

*Each question carries 10 marks.*

1. 0.04 m<sup>3</sup> of nitrogen contained in a cylinder behind a piston is initially at 1.05 bar and 15° C. The gas is compressed isothermally and reversibly until the pressure is 4.8 bar. Calculate. 2×3=6
  - (a) change of entropy
  - (b) the heat flow
  - (c) the work done

Sketch the process on a P-V and T-S diagram. 2×2=4
2. What are the uses of dimensional analysis in fluid mechanics ? List out the steps involved in Rayleigh's index method. 3+7=10
3. Derive an expression for velocity distribution for a Laminar flow between stationary parallel plates. 10
4. Derive an expression for critical thickness of insulation. 10
5. Briefly discuss the concept of Black body as a reference to compare emission and absorption characteristics of real bodies. 10
6. Describe briefly the working principle of impulse hydraulic turbines and reaction flow hydraulic turbines. 5×2=10
7. Compare the working principles of four stroke petrol engine with that of two stroke petrol engine. 10
8. A four stroke gasoline engine has a cylinder of 250 mm diameter, length of stroke 450 mm and is running at 180 rpm. Its mechanical efficiency is 80% when mean effective pressure is 0.65 MPa.  
Find (i) indicated power (ii) brake power, and (iii) friction power. 10
9. Draw a neat sketch of carburettor and show its parts. 10
10. Describe briefly fusion and fission processes of Nuclear energy. 10

## PART C

6×15=90

*Each question carries 15 marks.*

1. (a) In a process in which a system receives 30 kJ of heat from a reservoir and does 60 kJ of work, is it possible to reach initial state by an adiabatic process ? 7
- (b) Find the co-efficient of performance and heat transfer rate in the condenser of a refrigerator in kJ/hr which has a refrigeration capacity of 12000 kJ/hr when power input is 0.75 kW. 8
2. State Bernoulli's theorem. Derive the Bernoulli's equation. 5+10=15
3. In a convention heat transfer, explain with a neat sketch the different boundary layer flow regions on a flat plate. 15
4. (a) Compare the operating principle of Impulse and Reaction Steam turbines. 10
- (b) Explain briefly the function of a condenser. 5
5. A single cylinder, four stroke engine has a swept volume of 4.5 litre. The mean effective pressure is 0.65 MPa and the engine speed is 505 RPM. If there are 250 explosions per minute and brake torque is 176 Nm, find Indicated power and Brake power of the engine. 10+5=15
6. Explain Helio electrical process of converting solar energy into electrical energy. 15

**PART D**

3×30=90

Answer any **three** of the following questions, Each question carries 30 marks.

A fluid undergoes a reversible adiabatic compression from 4 bar, 0.3 m<sup>3</sup> to 0.08 m<sup>3</sup> according to law  $PV^{1.25} = \text{const.}$

Determine

30

300

- (a) change in enthalpy
- (b) change in internal energy
- (c) change in entropy
- (d) heat transfer
- (e) work transfer

(a) Explain with equation the following dimensionless parameters :

5×5=25

- (i) Reynolds's Number Re
- (ii) Froude Number Fr
- (iii) Mach Number M
- (iv) Weber Number W
- (v) Euler Number E

(b) What do you understand by Geometric similarity ?

5

Describe briefly the following Renewable energy forms and conversions :

10×3=30

- (a) Wind energy
- (b) Tidal energy
- (c) Ocean thermal energy

(a) With a neat sketch explain the working principle of Vapour Compression Refrigeration plant.

15

(b) Draw a typical air conditioning plant layout. Sketch and name the components/subsystem.

15

5. (a) With reference to IC engine define the following : 3×5=15
- (i) Mechanical efficiency
  - (ii) Brake thermal efficiency
  - (iii) Volumetric efficiency
  - (iv) Air standard efficiency
  - (v) Indicated thermal efficiency
- (b) Explain the following system in case of IC engines : 3×5=15
- (i) Ignition system
  - (ii) Cooling system
  - (iii) Lubrication system