

2006

MECHANICAL ENGINEERING - II (OPTIONAL)

Standard : Degree

Total Marks : 200

Nature : Conventional

Duration : 3 Hours

Note :

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- (i) Answers must be written in **English**.
- (ii) Question No. 1 is **Compulsory**. Of the remaining questions, attempt **any four** selecting one question from **each section**.
- (iii) Figures to the **RIGHT** indicate marks of the respective question.
- (iv) Use of log table, Non-Programmable calculator is permitted, but any other Table/Code/Reference book are not permitted.
- (v) Make suitable assumptions, wherever be necessary and state the same.
- (vi) Number of optional questions upto the prescribed number in the order in which they have been solved will only be assessed. Excess answers will not be assessed.
- (vii) Credit will be given for orderly, concise and effective writing.
- (viii) Candidate should not write roll number, any name (including their own), signature, address or any indication of their identity anywhere inside the answer book otherwise he will be penalised.

1. Answer any four of the following :

- (a) What are the three basic components of a simple gas turbine plant ? What is the air standard cycle of such a plant ? What are the processes it consists of ? **10**
- (b) (i) Explain with justification the most suitable nonconventional energy sources in the Indian context. **5**
- (ii) What are the advantages and disadvantages of wind energy source ? **5**
free, remote areas, reliable, erratic, low power density etc.
- (c) Differentiate S.I. engines and C.I. engines on the following points : **10**
P-v and T-s plots, thermal efficiency, power produced per unit weight of the engine, exhaust emissions, lubrication.

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| (d) (i) Explain with neat sketch the working principle of an orifice plate. List the advantages and limitations of orifice plate over venturi tube. | 5 |
| (ii) Explain with neat sketch the displacement measurement technique using LVDT (Linear Variable Differential Transformer). | 5 |
| (e) (i) Derive an expression for thermal efficiency in Rankine Cycle. | 5 |
| (ii) Explain with a neat sketch topping cycle steam turbine plant. | 5 |

SECTION - A

2. Answer the following sub-questions :

- (a) A 12 cylinder, single-acting, two stroke marine diesel engine has following specifications : 10
 Speed - 150 rpm, cylinder diameter - 0.8 m, stroke of piston - 1.2 m, Area of indicator diagram - $5.5 \times 10^{-4} \text{ m}^2$, Length of diagram - 0.06 m, spring value - 147 MPa/m. Find the net rate of work transfer from the gas to the piston in kW.
- (b) Represent Rankine Cycle on T-S plot and show that heat input is proportional to heat rejected and net work output. 10
- (c) What is the difference between the fin effectiveness and the fin efficiency ? 10
- (d) A radiation shield that has the same emissivity ϵ_3 on both sides is placed between two large parallel plates, which are maintained at uniform temperature of $T_1 = 650 \text{ K}$ and $T_2 = 400 \text{ K}$ and have emissivities of $\epsilon_1 = 0.6$ and $\epsilon_2 = 0.9$, respectively. Determine the emissivity of the radiation shield if the radiation heat transfer between the plates is to be reduced to 15 percent of that without the radiation shield. 10

3. Answer the following sub-questions :

- (a) A stationary mass of gas is compressed without friction from an initial state of 0.3 m^3 and 0.105 MPa to a final state of 0.15 m^3 and 0.105 MPa , the pressure remains constant during the process. There is a transfer of 37.6 kJ of heat from the gas during the process. How much does the internal energy of the gas change ? 10
- (b) How one can take the advantage of the increased efficiencies at the higher boiler pressures without facing the problem of excessive moisture at the final stage of the turbine ? 10
- (c) Water is boiling in a 25 cm diameter aluminium pan ($K = 237 \text{ W/m}^\circ \text{C}$) at 95°C . Heat is transferred steadily to the boiling water in the pan through its 0.5 cm thick flat bottom at a rate of 800 W . If the inner surface temperature of bottom of the pan is 108°C , determine 10
- (i) the boiling heat transfer coefficient on the inner surface of the pan, and
- (ii) the outer surface temperature of the bottom of the pan.

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- (d) A double - pipe heat exchanger is constructed of a copper ($K = 380 \text{ W/m}^\circ\text{C}$) inner tube of internal diameter $D_i = 1.2 \text{ cm}$ and external diameter $D_o = 1.6 \text{ cm}$ and an outer tube of diameter 3.0 cm . The convection heat transfer coefficient is reported to be $h_i = 700 \text{ W/m}^2^\circ\text{C}$ on the inner surface of the tube and $h_o = 1400 \text{ W/m}^2^\circ\text{C}$ on its outer surface. For a fouling factor $R_{fi} = 0.0005 \text{ m}^2^\circ\text{C/W}$ on the tube side and $R_{fo} = 0.0002 \text{ m}^2^\circ\text{C/W}$ on the shell side, determine :
- (i) the thermal resistance of the heat exchanger per unit length.
- (ii) the overall heat transfer coefficients V_i and V_o based on the inner and outer surface area of the tube, respectively.

10

SECTION - B

4. Answer the following sub-questions :

- (a) (i) State and explain Reynold's Transport Theorem. 5
- (ii) Show that the maximum efficiency in power transmitted by a pipeline is 67%. 5
- (b) (i) Explain classification of hydraulic turbines. 4
- (ii) Explain the following in pumps : 6
- (a) Net positive suction head
- (b) Positive and Non-positive displacement
- (c) Slip
- (d) Priming
- (c) (i) Explain with a neat sketch : 4
- (a) a directional control valve,
- (b) a flow control valve.
- (ii) Compare hydraulic and pneumatic systems. 4
- (iii) What are the uses of compressed air in an engineering fabrication unit ? 2
- (d) Explain with a neat sketch and with the help of a T - S diagram Brayton - Rankine combined cycle power plant. Under which circumstances combined cycle plant is preferred ? 10

9. Answer the following sub-questions : Marks
- (a) Define and explain in brief the following terms : 10
- (i) Roughness
 - (ii) Waviness
 - (iii) Lay
 - (iv) Ra Value
 - (v) Rz value
- (b) (i) Describe punch tape codes in EIA and ISO forms. 3
- (ii) What makes an incremental shaft encoder particularly an attractive device for NC machine tools ? 2
- (c) (i) Find the roots of the following equation : 10
- $$f(x) = x \sin x + \cos x = 0$$
- Use Newton Raphson method. Accuracy of the roots should be upto 4 decimal places.
- (ii) Explain in brief the following terms : 5
- (a) Algebraic equation
 - (b) Transcendental equation
- (d) (i) Draw the neat sketch of a DC motor speed control system. Also explain in brief. 6
- (ii) Explain in brief the following : 4
- (a) Gain Margin
 - (b) Phase Margin

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5.	<i>Answer the following sub-questions :</i>	
(a)	(i) Explain the significance of Reynold's number, Mach number, Euler number and Weber number in the study of fluid flow.	5
	(ii) State and explain the significance of Navier Stoke's equations in the study of fluid dynamics.	5
(b)	(i) Derive an expression for intermediate pressure for a two stage compressor with perfect intercooling.	6
	(ii) What are the losses in centrifugal compressor ?	4
(c)	Explain with a neat sketch components of an air compressor installation to be used for a pneumatic press.	10
(d)	(i) What are the advantages and disadvantages of fluidized bed combustion ?	5
	(ii) What are the characteristics of gas turbine power plant in respect of meeting electricity demand ?	5

SECTION - C

6.	<i>Answer the following sub-questions :</i>	
(a)	A four stroke diesel engine has a piston diameter of 16.5 cm and a stroke of 27 cm. The compression ratio is 14.3, the cut-off 4.23% of the stroke and the mean effective pressure 4.12 bar. The engine speed is 264 rpm and the fuel consumption is 1.076 kg per hour, having a specific value of 39150 kJ kg. Calculate the relative efficiency of the engine.	10
(b)	(i) Give classification of automobile engines alongwith speed and power developed by each engine. Minimum seven engines and their speed and power development at rated conditions.	7
	(ii) Explain various methods to measure the brake power of an I.C. engine. Illustrate step by step procedure to carry out the Morse test of an automobile engine.	8
(c)	(i) Explain the types of evaporaters and condensers of refrigeration system. At least two types of each.	8
	(ii) Classify the cooling loads of an air conditioning space. How do you calculate the heat gain/load of a conditioned room due to solar radiation and internal sources ?	7

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7. *Answer the following sub-questions :*

- (a) With the help of a block diagram illustrate the working of common rail fuel injection system and individual pump injection. 10
- (b) (i) Compare front wheel drive and rear wheel drive system of an automobile. 7
(ii) What are the resistances to the motion of automobile ? Explain the method to measure one of the resistances to automobile motion. 8
- (c) (i) An ice plant produces 12 tonnes of ice per day at 0°C, using water at room temperature of 15°C. If the COP of the plant is 2.6 and overall electro-mechanical efficiency 87%, find the power rating of the compressor motor. One can assume latent heat of ice 335 kJ/kg and the specific heat of water 4186 J/kgK. 7
(ii) Name the instruments to measure static pressure and dynamic pressure of air flowing through a duct. 8
Explain the concept of equal friction method to size the air duct.

SECTION - D

8. *Answer the following sub-questions :*

- (a) (i) A limit gauge is required to check the hole 60H8f7. Neglecting wear allowance, design the GO and NOT-GO limit gauges for checking this hole. Assume IT8 = 25*i*; IT7 = 16*i* where *i* is the tolerance unit. Diameter step is 50 to 80 mm. 5
- (ii) (a) What gives NC machines their inherent flexibility ? 3
(b) Explain the difference in two main forms of adaptive control. 3
(c) Explain four types of control modes on NC machines. 4
- (b) Use Gauss Elimination method to solve the following simultaneous equations : 15
 $x_1 + 2x_2 + 4x_3 = 4$
 $x_2 + x_3 = 6$
 $4x_1 + 5x_2 + 3x_3 = 8$
Also write down its algorithm and draw the flowchart for the same.
- (c) With the help of neat sketch explain the following terms : 10
(i) Percentage overshoot
(ii) Damping factor
(iii) Settling time
(iv) Steady state error
(v) Rise time and fall time
Also state their significances.

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