

**3E1413**

Roll No. : \_\_\_\_\_

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B. Tech. (Sem. III) (Main & Back) Examination, January - 2013  
Production & Industrial Engg.  
3PI3 Engineering Thermodynamics (Common for ME/AE)

Time : 3 Hours]

[Total Marks : 80

[Min. Passing Marks : 24

*Attempt any five questions, selecting one question from each unit. All questions carry equal marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly.*

*Units of quantities used/calculated must be stated clearly.*

Use of following supporting material is permitted during examination.

(Mentioned in form No. 205)

1. Steam Table2. Mollier Chart

### UNIT - I

- 1 (a) Express the Van der Wall's equation of state in terms of reduced parameters. How does it differ from ideal gas equation.

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- (b) A U-tube mercury manometer has been employed to measure the pressure of gas following through a pipe line. One limb of the manometer communicates with the gas pressure and the other limb is open to atmosphere. If the difference in level of mercury in the two limb is 40 cm, determine the gas pressure.

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OR

- 1 (a) State the difference between extensive, intensive and specific properties of a thermodynamic system.

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[Contd...

(b) Air at 20°C and 7 bar is contained in a rigid tank of 0.57 m<sup>3</sup> volume capacity. The tank is provided with a valve that opens at a pressure of 8.5 bar and remains open until the pressure drops to 8.15 bar. Determine :

(a) Air temperature just before the valve opens

(b) Mass of air lost due to fire.

Assuming : A fire occurs and causes the valve to open and the temperature of the air remains constant during discharge and air in the tank behaves as an ideal gas.

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## UNIT - II

2 (a) Give Kelvin-Planck statement of second law of thermodynamics and discuss the process involved in a Carnot cycle.

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(b) Discuss why the second law of thermodynamics is called as a "Directional law of Nature".

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## OR

2 (a) Deduce clausius inequality and interpret it.

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(b) One kg of air initially at 7 bar pressure and 360 k temperature expands polytropically ( $pv^{1.2} = \text{const.}$ ) until the pressure reduced to 1.4 bar. Determine :

(i) Final specific volume and temperature

(ii) Change of internal energy

(iii) Work done and heat interaction.

(iv) Change in entropy.

Take  $R = 287 \text{ J/kg K}$  and  $\gamma = 1.4$ .

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### UNIT - III

- 3 (a) Derive the clausius - clapreyon equation. 8
- (b) Define irreversibility. Show that irreversibility of a process is given by the product of the temperature of surroundings and the net entropy change. 8

OR

- 3 (a) Derive Maxwell's equation. 10
- (b) Prove that :  $Tds = CvdT + T\left(\frac{\partial p}{\partial T}\right)_V dV$  6

### UNIT - IV

- 4 (a) Derive an expression for the air standard efficiency of a Brayton cycle in terms of pressure ratio. 8
- (b) An engine working on Diesel cycle has a compression ratio of 15 and fuel supply is cut off at 8% of stroke. If the engine has a relative efficiency of 50%, determine the fuel consumption per kW-hr. Assume the fuel has a calorific value of 42000 kJ/kg. 8

OR

- 4 (a) Consider an air standard otto cycle that has a heat addition of 2800 kJ/kg of air, a compression ratio of 8 and a pressure and temperature at the beginning of compression process of 1 bar, 300 k. Determine :
- (i) Maximum pressure and temperature in the cycle
- (ii) Thermal efficiency
- (iii) Mean effective pressure.

Assume for air  $C_p = 1.005$  kJ/kg K,  $C_v = 0.718$  kJ/kg K and  $R = 287$  kJ/kg K.

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- (b) Explain any four types of classification of an Internal combustion engines.

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### UNIT - V

- 5 (a) Draw a Rankine cycle with one type feed water heater. Assume the condition of the steam before entering the turbine to be superheated. Sketch the cycle on T.S diagram.

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- (b) A steam power plant operates on a theoretical reheat cycle. Steam at 25 bar pressure and 400°C is supplied to the high pressure turbine. After its expansion to dry state, the steam is reheated at constant pressure to its original temperature. Subsequent expansion occurs in the low pressure turbine to a condenser pressure of 0.04 bar. Considering feed pump work, Calculate :

- (i) Quality of steam at entry to condenser
- (ii) Thermal efficiency
- (iii) Specific steam consumption.

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OR

- 5 Sketch the layout of various components comprising the vapour compression refrigeration cycle, and explain its working.

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