



Name :

Roll No. :

Invigilator's Signature :

CS/B.TECH(AUE-OLD)/SEM-3/AUE-303/2011-12

2011

ENGINEERING THERMODYNAMICS

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$
 - i) Thermodynamic properties are
 - a) path functions
 - b) point functions
 - c) may be path or point functions
 - d) none of these.
 - ii) A heat engine is supplied heat at the rate of 30,000 J/S and gives an output of 9 kW. The thermal efficiency of the engine will be
 - a) 30%
 - b) 33%
 - c) 40%
 - d) 50%.



- iii) In a thermodynamic cycle
- a) complete conversion of heat into work is possible
 - b) complete conversion of heat into work is impossible
 - c) heat and work are completely interchangeable
 - d) none of these.
- iv) Any spontaneous process is
- a) reversible
 - b) irreversible
 - c) may be reversible or irreversible
 - d) none of these.
- v) Entropy generation of a reversible system is
- a) positive
 - b) negative
 - c) zero
 - d) dependent on the process.



vi) Which of the following is always true ?

- a) $\oint \frac{dQ}{T} = 0$ b) $\oint \frac{dQ}{T} > 0$
 c) $\oint \frac{dQ}{T} \geq 0$ d) $\oint \frac{dQ}{T} \leq 0$.

vii) For a mercury-steam binary cycle if the topping cycle has the efficiency 0.5 and the bottom cycle has the efficiency 0.40. What is the efficiency of the combined cycle ?

- a) 0.45 b) 0.55
 c) 0.70 d) 0.75.

viii) The equation $Tds = dH - Vdp$ holds good for

- a) reversible process only
 b) irreversible process only
 c) isentropic process only
 d) any process.

ix) For same maximum pressure and temperature and same heat ejection between Otto cycle and Diesel cycle

- a) Otto cycle is more efficient
 b) Diesel cycle is more efficient
 c) both are equal efficient
 d) efficiency cannot be compared.

a) 0.5 b) 1
c) 0.75 d) 0.

(Short Answer Type Questions)

2. What is enthalpy ? Starting from steady flow energy equation, show that for a throttling process enthalpy of the fluid remains constant. 2 + 3
3. What is Clausius' theorem ? Show that entropy is a thermodynamic property. 2 + 3
4. Explain that *Rankine* cycle is more suitable than Carnot cycle for steam power plants.
5. What is one tone of refrigeration ? What is the chemical formula of refrigerant R-110 ? 3 + 2
6. What is specific humidity ?

P_w is partial pressure of water vapour and P is the atmospheric pressure. 2 + 3



GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) What are the causes of irreversibility ?
- b) Between a 1 kW electric heater and 1 kW heat pump, which one is more efficient to heat a room ? Give explanation to your answer.
- c) A domestic food freezer maintains a temperature maintains a temperature of -15°C . The ambient air temperature is 30°C . If heat leaks into the freezer at the continuous rate of 1.75 kJ/s, what is the least power necessary to pump this heat out continuously ?

4 + 4 + 7

8. a) Show that the efficiency of Rankine cycle is a function of mean temperature of heat addition.
- b) Steam at 20 bar, 360°C is expanded in a steam turbine to 0.08 bar, then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assuming ideal process find,
- (i) Per kg of steam the net work and cycle efficiency
- (ii) If the turbine and the pump have each 80% efficiency, find percentage reduction in the net work and cycle efficiency.

3 + (7 + 5)



9. a) What is dew point temperature ?
- b) A simple R-12 plant is to develop 5 tonnes of refrigeration. The condenser and evaporator temperatures are to be 40°C and -10°C respectively. Determine :
- the refrigerant flow rate
 - the volume flow rate handled by the compressor
 - power required to drive the compressor
 - the pressure ratio
 - the COP
 - heat rejected to the condenser. 3 + (2 × 6)
10. a) Show that the efficiency of diesel cycle is
- $$\eta_{Diesel} = 1 - \frac{1}{\gamma} \times \frac{1}{r_k^{\gamma-1}} \times \frac{r_c^{\gamma-1} - 1}{r_c - 1}$$
- b) An air standard dual cycle has a compression ratio of 16, and compression begins at 1 bar, 50°C. The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. Estimate,
- the pressure and temperature at the cardinal points of the cycle
 - the cycle efficiency. 5 + (5 + 5)



11. a) Prove that the volumetric efficiency of a reciprocating compressor is

$$\eta_{vol} = 1 + C + C \times \left(\frac{p_2}{p_1} \right)^{\frac{1}{n}}$$

Where, C is the clearance and p_2 and p_1 are the discharge and suction pressures respectively.

- b) A diesel engine has a compression ratio of 14 and cut-off takes place at 6% of stroke. Find the air standard efficiency. 7 + 8
