Total No. of Questions—**12**] [Total No. of Printed Pages—**4+2**

Seat No.	

[4857]-111

S.E. (Mechanical/Automobile) (First Semester)
EXAMINATION, 2015
APPLIED THERMODYNAMICS
(2008 PATTERN)

Time : Three Hours **Maximum Marks : 100**

N.B. **:—** (*i*) Answer *three* questions from Section I and *three* questions from Section II.
(*ii*) Answer to the two sections should be written in separate answer-books.
(*iii*) Neat diagrams must be drawn wherever necessary.
(*iv*) Figures to the right indicate full marks.
(*v*) Use of calculator is allowed.
(*vi*) Assume suitable data, if necessary.

SECTION I
UNIT I

1. (*a*) What is the first law of thermodynamics ? Discuss its limitations. [6]
(*b*) Prove that entropy is a property of the system. [4]
(*c*) A cyclic heat engine operates between a source temperature of 800°C and a sink temperature of 30°C. What is the least rate of heat rejection per kW net output of the engine ? [6]

Or

2. (*a*) Explain with neat sketch the following statements of second law of thermodynamics : [6]
(*i*) Clausius statement
(*ii*) Kelvin-Planck statement.

P.T.O.

(*b*) Define Heat engine and heat pump. [4]

(*c*) Air at 10 bar and 250°C contained in a vessel having 0.28 m^3 volume is cooled until its pressure drops to 3.5 bar. Determine change in entropy. [6]

UNIT II

3. (*a*) Derive equation of state an ideal gas. [6]

(*b*) A mass of 0.25 kg of an ideal gas has a pressure of 300 kPa, temperature of 80°C and volume of 0.07 m^3. It undergoes an irreversible adiabatic process to a final pressure of 300 kPa and final volume of 0.1 m^3 during which work done on the gas is 25 kJ. Evaluate specific heat at constant pressure and constant volume. [6]

(*c*) Explain second law of efficiency. [4]

Or

4. (*a*) Derive the expression for work done and heat supplied in a steady flow polytropic process. [6]

(*b*) 1 kg of air at 500 K is heated reversibly at constant pressure to 2000 K. Find the available energy and unavailable. [6]

(*c*) Write a short note on 'Irreversibility'. [4]

UNIT III

5. (*a*) With a neat sketch explain working of separating calorimeter. [6]

(*b*) Define : [4]

(*i*) Specific steam consumption

(*ii*) Work ratio.

(*c*) A Rankine cycle operates between boiler pressure of 10 MPa and condenser pressure of 5 kPa. Determine the thermal efficiency, work ratio and specific steam consumption. [8]

Or

6. (*a*) Explain : [6]

(*i*) Enthalpy of liquid

(*ii*) Enthalpy of vaporization or latent heat of vaporization

(*iii*) Internal energy of steam.

(*b*) Discuss the effect of superheated steam, Boiler pressure and condenser pressure on performance of Rankine cycle. [6]

(*c*) Find out specific volume of steam when its pressure is 7 bar and when the condition of steam is : [6]

(*i*) Wet having dryness fraction 0.2

(*ii*) Dry saturated

(*iii*) Superheated, the temperature being 250°C.

SECTION II

UNIT IV

7. (*a*) Define HCV and LCV of the fuel. [4]

(*b*) Derive an expression for minimum quantity of air required for complete combustion of 1 kg of fuel assuming that fuel contains carbon, hydrogen, sulphur and oxygen as constituents. [6]

(*c*) A gas consists of the following % analysis by mass : [6]

CO–30%, N_2–20%, CH_4–15%, H_2–25% and O_2–10%.

Determine the % composition of the gas by volume.

Or

8. (*a*) Explain Boys' gas calorimeter with a neat sketch. [8]

(*b*) During Bomb calorimeter test on diesel oil, the following data were recorded : [8]

Room temperature = 25°C

Weight of crucible = 8.231 gm,

Weight of crucible and diesel oil = 8.803 gm,

Weight of calorimetric vessel = 1.05 kg,

Weight of water and calorimeter vessel = 3.5 kg,

Water equivalent of calorimeter = 0.56 kg,

Rise in temperature of water and calorimeter = 2.35°C,

Cooling correction = 0.02°C.

Find the HCV and LCV when mass of condensate is 0.32 gm. The partial pressure of water vapour is 8 kPa.

UNIT V

9. (*a*) Define : [4]

(*i*) Isothermal efficiency

(*ii*) Volumetric efficiency.

(*b*) With neat sketch explain single stage reciprocating compressor. [6]

(*c*) A two stage, double acting air compressor runs at 120 rpm. It draws in air at 1 bar and 293 K and compressor it with a total pressure ratio of 10. The intercooler used in between the stages works at a pressure of 3 bar and the air is cooled in it upto a temperature of 302 K. Determine the shaft power of the compressor having mechanical efficiency and volumetric efficiency of 90% and 82% respectively. The diameter of LP cylinder is 25 cm and stroke is 37.5 cm. The index of compression for each stage is 1.3. [8]

Or

10. (*a*) Explain with a neat sketch any *one* of rotary compressor. [4]

(*b*) What are the advantages of multi-staging in reciprocating air compressor ? [4]

(*c*) A single stage, single acting air compressor has a bore of 200 mm and stroke 300 mm. It runs at 420 rpm and has a clearance ratio of 0.065. The index of compression can be assumed as 1.3. The intake pressure is 1 bar and intake temperature is 27°C. Delivery pressure is 500 kPa. Determine :

(*i*) FAD at NTP in m^3/hr

(*ii*) Volumetric efficiency

(*iii*) Delivery air temperature

(*iv*) Power required and

Isothermal efficiency. [10]

UNIT VI

11. (*a*) What is steam generator ? Classify steam generator. [4]

(*b*) Write a short note on IBR boilers. [4]

(*c*) The following results were obtained from a boiler trial :

Feed water per hour = 700 kg,

Feed water temperature = 27°C

Steam pressure = 8 bar, dryness = 0.97

Coal consumption = 100 kg/hr, C_v = 25000 kJ/kg

Flue formed/kg of fuel = 17.3 kg, Flue temperature = 325°C

C_p of gas = 1.025 kJ/kgK, room temperature = 16°C

Draw up heat balance sheet on kJ/min and percentage basis. Determine boiler efficiency and equivalent evaporation and factor of evaporation. [8]

Or

12. (*a*) Define and explain terms : [4]

(*i*) Equivalent evaporation

(*ii*) Boiler efficiency.

(*b*) Explain the heat balance sheet for a boiler plant. [4]

(*c*) In an experiment on small oil fired boiler, the steam produced is 6 bar gauge. The quality of steam produced is found to be 0.96. 75 liters of water is converted into steam in 9.5 min. The fuel is light diesel oil with specific gravity of 0.85 and calorific value of 43125 kJ/kg. Ten liters of oil is consumed in 11 min. and 25 seconds. The feed water temperature is 35°C. Determine the boiler efficiency and equivalent evaporation. Take atmospheric pressure of 1 bar. [8]