Seat No. | | | | | | |

* 2 6 0 5 *

BBI1301

Applied Thermodynamics (New)
(1050)

P. Pages : 3

Time : Three Hours

Max. Marks : 100

Instructions to Candidates :
1. Do not write anything on question paper except Seat No.
2. Answersheet should be written with blue ink only. Graph or diagram should be drawn with the same pen being used for writing paper or black HB pencil.
3. Students should note, no supplement will be provided.
4. Solve **any two** subquestions from each unit.
5. All **five** questions are compulsory.
6. Draw neat sketches wherever necessary.
7. Figure on right side indicate maximum marks.
8. Use of electronic non programable calculator and steam table Mollier chart is allowed.

UNIT - I

1. a) Explain following terms : **any five.** **10**

1) Proximate analysis
2) Stoichiometric Air
3) Equivalence Ratio
4) Enthalpy of reaction
5) Calorimeter
6) Net calorific value
7) Gross Calorific value.

b) A sample of dry coal has following composition by mass - C - 90%, H - 3%, O - 2.5%, Sulpher - 0.5%, ash - 3%.
Calculate :
i) Stoichiometric air fuel ratio
ii) Actual air fuel ratio
iii) dry and wet flue gas analysis of products by mass and by volume when 30% excess air is supplied. **10**

c) C_7H_{16} is burnt with 30% excess air. Find the volumetric percentage analysis of fuel & the products of combustion. Also determine the molecular weight, specific volume and characteristic gas constant for products of combustion at STP [1 bar, 25^0C] **10**

UNIT - II

2. a) Write short notes on : **10**

i) Loeffler Boiler

ii) LaMont Boiler

b) Data recorded during a boiler trial that lasted for 2 hours. Feed water supplied - 14000kg, Temperature of feed water at entry and exit of economiser are 35^0C and 90^0C, boiler pressure = 10 bar, dryness fraction of steam = 0.96, temperature of steam leaving superheater = 250^0C, coal burnt 1500kg CV of fuel = 33500 kJ/kg.
Calculate :
1) Heat supplied to water substance in economiser, boiler and superheater,
2) Thermal efficiency of economiser, boiler and superheater,
3) Plant thermal efficiency,
4) Overall equivalent evaporation from & at 100^0C. **10**

c) During a boiler test data obtained were = Mean temp. of flue gases = 550k, Temperature of cold air = 300k, air fuel ratio used = 18 : 1 fuel used = 1800kg/hr draught required = 100mm of water Mechanical efficiency = 80%. Calculate motor power of forced draught fan and induced draught fan considering 10% allowance for air leakage in both cases. Take sp. volume of air at NTP as 0.7734 m^3/kg. **10**

UNIT - III

3. a) Why is a cooling tower used in steam power plant ? Explain natural draft and mechanical draft cooling tower. **6**

Explain losses due to irreversibility in Rankine cycle. **4**

b) A steam power plant operates on ideal Rankine cycle between boiler pressure of 40 bar, 300^0C and condenser pressure of 0.035 bar.
Calculate cycle efficiency, work ratio and specific steam consumption for-
a) ideal Rankine cycle.
b) For Rankine cycle where expansion process has isentropic efficiency of 80% **10**

c) A condenser of $0.75m^3$ capacity contains saturated steam and air at a temperature of 45^0C and pressure 0.13 bar (abs). Further, leakage of air into condenser increases pressure to 0.28 bar (absolute) and temperature falls to 38^0C. Find out the mass of air leaked into the condenser. **10**

UNIT - IV

4. a) A steam enters a convergent divergent nozzle at pressure 2MPa, 400^0C with negligible velocity and flow rate of 2.5 kg/s. Steam exists nozzle at pressure 300 kPa. The expansion is isentropic upto throat and overall nozzle efficiency is 93%.
Determine throat and exit areas for nozzle. **10**

b) A convergent divergent nozzle receives steam at 7 bar, 200^0C and expands it isentropicaly to 3 bar. Neglect approach velocity. Calculate the exit area required for flow of 0.1 kg/s
i) When flow is in equilibrium throughout.
ii) When flow is supersaturated with $pV^{1.3}$ = constant. **10**

c) Derive the equation for isentropic flow of fluid through a duct. **10**

$$\frac{dA}{A} = \frac{d\rho}{\rho}\left[\frac{1-M^2}{M^2}\right]$$

where ρ (rho) is density.

UNIT - V

5. a) A single stage double acting reciprocating compressor sucks in air at 1bar, 27^0C and delivers it at 7 bar. The index of compression is 1.3 and index of expansion is 1.35. Surrounding conditions are 1.03 bar and 20^0C. Compressor delivers 2 m^3/min of free air while running at 300 RPM. It has clearance volume ratio of 5%. Calculate volumetric efficiency. Indicated power and brake power for mechanical efficiency of 80%. **10**

b) A double stage single acting RAC takes air in at 1 bar, 300k and discharges at 10 bar and 0.1kg/s. The law of compression is $pV^{1.3}$ = constant. Assume perfect intercooling & optimum work condition. Calculate - indicated power, isothemal efficiency, saving in work due to multistaging and rate of heat transfer in intercooler. **10**

c) What is volumetric efficiency of a reciprocating air compressor ? Derive an equation for the same for single stage compressor.
Explain how different factors affect volumetric efficiency adversely. **10**

****