BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI, DUBAI CAMPUS

I SEMESTER 2013-2014

Comprehensive Exam (Closed Book)

Year : II-MECHANICAL	**Section: 1 and 2**	**Date : 06.01.2014**
Course No. : ME F214	**Course Title : APPLIED THERMODYNAMICS**	
Duration : 3 hrs	**Marks: 80**	**Weightage : 40 %**

Notes: (i) *answer all the questions* (ii) *Draw neat sketches wherever necessary*

(iii) *Make suitable assumptions if required and clearly state them (iv) Steam table will be provided*

Q.1. In a constant volume 'Otto cycle', the pressure at the end of compression is 15 times that at the start, the temperature of air at the beginning of compression is 38°C and maximum temperature attained in the cycle is 1950°C.

Determine: (a) Compression ratio (b) Temperature at the end of Compression (c) Temperature at the end of expansion (d) Work done (e) Thermal efficiency per kg of air Take γ for air = 1.4 and C_v =0.717 kJ/kg-k [11 Marks]

Q.2. An ammonia refrigerator produces 30 tonnes of ice from and at 0^0C in a day of 24 hours. The plant operates between evaporation and condensation temperatures of -25^0C and 15^0C respectively. At the end of the compression the condition of vapour is dry and saturated. Assume a coefficient of performance of 60 % of the theoretical and Latent heat of ice is 334.72 kJ/kg.

The properties of ammonia as listed in the table

Temp ^{0}C	Enthalpy kJ/kg		Entropy kJ/kg K	
	Sat. liquid, $\mathbf{h_f}$	Sat. vapour, $\mathbf{h_g}$	Sat. liquid, $\mathbf{s_f}$	Sat. vapour, $\mathbf{s_g}$
15	100.04	1319.22	0.3473	4.4852
- 25	-54.56	1304.99	-2.1338	5.0585

Calculate: (a) Refrigerant plant capacity in kW (b) Dryness fraction of refrigerant (c) Theoretical COP of the plant (d) Actual COP of the plant(e) Actual refrigerating effect per kg (f) Mass flow rate of refrigerant kg per second (g) power required to drive the compressor in kW. [11 Marks]

Q.3. A gas turbine unit has a pressure ratio of 6: 1 and maximum cycle temperature of 610°C. The isentropic efficiencies of the compressor and turbine are 0.80 and 0.82 respectively. The air enters the compressor at 15°C at the flow rate of 16 kg/s.

Take C_p = 1.005 kJ/kg K and γ = 1.4 for the compression process, and take C_p = 1.11 kJ/kg K and γ = 1.333 for the expansion process. Determine:

(a) The isentropic and actual temperature at the end of compressor (b) The isentropic and actual temperature at the end of expansion in the turbine (c) Compressor work input in kW (d) Turbine work output in kW (e) Net work output of the plant

[11Marks]

Q.4. The following data are provided for two boilers:

Steam pressure in bar		Quality of steam	Rate of Steam generation
Boiler '**A**'	10 bar	0.91	8.5 kg / kg of coal
Boiler '**B**'	16 bar	Super heated to 250 ^{0}C	6.95 kg / kg of coal

Both the boilers are supplied with feed water at 30 ^{0}C. Select the boiler which has higher equivalent evaporation per kg of coal [9 Marks]

Q.5. The atmospheric conditions are; Dry bulb temperature 20°C and specific humidity of 0.0095 kg/kg of dry air. Calculate the following:

(i) Partial pressure of vapour (ii) Relative humidity

(iii) Dew point temperature. [7 Marks]

Q.6. In a Rankine cycle, the steam at inlet to turbine is dry and saturated at a pressure of 35 bar and the exhaust pressure of 0.2 bar. Determine:

(a) The pump work (b) The Rankine efficiency (c) The condenser heat flow

(d) The dryness at the end of expansion. Assume steam flow rate of 9.5 kg/s

[11 Marks]

Q.7. A single stage single acting air compressor delivers 0.6 kg of air per minute at 6 bar. The temperature and pressure at the end of suction stroke are 30^0C and 1 bar. The bore and stroke of the compressor are 100 mm and 150 mm respectively. The clearance is 3% swept volume. Assuming the index of compression and expansion to be 1.3, find

(i) Volumetric efficiency of the compressor

(ii) Power required if mechanical efficiency is 85% and

(iii) Speed of the compressor(r.p.m) [11Marks]

Q.8. Explain with figure the salient features of Brayton / Rankine combined cycle power pant [9 Marks]

******* **ALL THE BEST** *******

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI, DUBAI CAMPUS

I SEMESTER 2013-2014

Test No.2 (Open Book)

Year : II-MECHANICAL	Section: 1 and 2	Date : 10.12.2013
Course No. : ME F214	Course Title : APPLIED THERMODYNAMICS	
Duration : 50Min	Marks: 40	Weightage : 20 %

Notes: *(i) answer all the questions (ii) Draw neat sketches wherever necessary*
(iii) Make suitable assumptions if required and clearly state them

Q.1 **Freon-12 installation has the following Data:**

- Capacity of the plant = 15 TR
- Evaporator temperature = - 10 ^{0}C
- Condenser temperature = 30 ^{0}C
- Temperature of refrigerant after the evaporator and before entering to the compressor in the super heated region (not at the saturated vapor line) = - 5 ^{0}C
- Temperature of refrigerant is sub cooled in the saturated liquid line after the condenser and before entering the expansion valve = 25 ^{0}C

Compressor particulars:

Numbers of cylinder = 2, Bore =1.5 times stroke, RPM=960

Assume the enthalpy of sub-cooled refrigerant is 224.3 kJ/kg.

Take: Liquid specific heat = 0.963 kJ/kg K, Vapour specific heat = 0.615 kJ/kg K.

Determine: (i) Refrigerating effect per kg. (ii) Mass of refrigerant to be circulated per minute (iii) Theoretical piston displacement per minute (iv) COP of the plant (v) Heat removed in the condenser per kg (vi) Theoretical power required to run the compressor in kW (vii) Theoretical bore and stroke of compressor. **[15M]**

Properties of Freon-12

Saturation temperature t_s °C	*Absolute pressure* p bar	*Specific volume* v_g m^3/kg	*Enthalpy of liquid* h_f kJ/kg	*Enthalpy of vapour* h_g kJ/kg	*Entropy of liquid* s_f kJ/kg °K	*Entropy of vapour* s_g kJ/kg °K
– 10	2.1928	0.07702	190.72	347.96	0.96561	1.5632
+ 30	7.4457	0.02372	229.11	364.96	1.0999	1.5481

Q.2 **(a)** when do the DBT, WBT and DPT become equal? **[2M]**

(b) A mixture of dry air and water vapour is at a temperature of 21^0C under a total pressure of 736 mm of Hg. The dew point temperature is 15^0C find

I. Relative humidity

II. Sp.humidity

III. Sp. Volume of air per kg of dry air

It is given that the partial pressure of water vapour at 15^0C is 1707.5 N/m^2 and saturation pressure of water vapour at 21^0C is 2489,8 N/m^2 **[7 M]**

Q.3 **(a)** What is the effect of irreversibility's in turbine and compressor on Brayton cycle efficiency? **[4 M]**

(b) In a gas turbine plant working on the Brayton cycle the air at the inlet is at 27^0C, 0.1 MPa. The pressure ratio is 6.25 and the maximum temperature is at 800^0C. The turbine and the compressor isentropic efficiencies are each 80%. Find a) the compressor work per kg of air (b) the turbine work per kg of air (c) the heat supplied per kg of air (d) the cycle efficiency, and (e) the turbine exhaust temperature **[12M]**

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI, DUBAI CAMPUS

FIRST SEMESTER 2013-2014

Test No.1 (Closed Book)

Year : II-MECHANICAL	Section: 1 and 2	Date : 08.10.2013
Course No. : ME F214	Course Title : APPLIED THERMODYNAMICS	
Duration : 50Min	Marks: 50	Weightage : 25 %

Notes: (i) *answer all the questions* (ii) *Draw neat sketches wherever necessary*

(iii) *Make suitable assumptions if required and clearly state them (iv) Steam table will be provided*

Q.1 Distinguish between Otto cycle and Diesel Cycle with respect to T-s diagrams **[8M]**

Q.2 An engine is operating on Ideal Otto cycle has maximum temperature of 1277^{o} C. The temperature of air after the expansion is 447^{O} C. The condition at the start of the cycle is pressure 1 bar and temperature 37 ^{0}C. The air consumption of the cycle is 2 kg per minute. .Assume air as working substance with C_v = 0.718 kJ/kg-k,
R for air = 0.287 kJ/kg-k and γ = 1.4
Calculate (i) compression ratio (ii) Air standard efficiency of the cycle (iii) work done per kg of air (iv) power output **[17M]**

Q.3 State the methods of increasing the thermal efficiency of a Rankine cycle **[6M]**

Q.4. Compare Carnot cycle with Rankine cycle **[5M]**

Q.5 In a Rankine cycle, the steam at inlet to turbine is dry and saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine: (i) the pump work(ii) the turbine work(iii) the rankine efficiency (iv) the condenser heat flow (v) The dryness fraction at the end of expansion .Assume mass flow rate of steam is 9.5 kg/s **[14M]**

GOOD LUCK
