BITS, PILANI-DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006-2007

II Year

ME UC211 APPLIED THERMODYNAMICS Comprehensive Exam DATE: 20-05-07

DURATION: 3hrs MAXIMUM MARKS: 40 WEIGHTAGE: 40%

Notes: Thermodynamic tables are allowed.

Highlight all your answers by enclosing in boxes. Assume any missing data suitably and mention the same at the appropriate place in your answer. All the parts of the same question should be answered together.

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1. a. Represent the air standard Ericsson cycle in PV and TS coordinates and derive the expression for the efficiency of the cycle. Why the Ericsson cycle efficiency is less than the Carnot cycle. **4**

   b. Draw the actual and theoretical P-V diagrams of a four stroke SI engine and explain the salient points and state why the two diagrams differ each other. **3**

2. Consider a steam power plant operating on the ideal Rankine cycle. The steam enters the turbine at 3 MPa and 350°C and is condensed in the condenser at a pressure of 10kpa. Determine i) the thermal efficiency of the plant ii) the percentage increase in thermal efficiency if the steam is super heated to 600°C instead of 350°C. **7**

3. Explain the four stages of combustion in a diesel engine with a P-θ diagram. **4**

4. Single acting single cylinder air compressor is required to deliver 6 m^3 free air per minute at mean piston speed of 200m/min. The air is compressed from 1 bar to 8 bar. The clearance is 1/15 of the stroke and the stroke is 1.25 times that of its diameter. Assuming the index of compression and re-expansion is 1.3 and the suction and ambient conditions are same find a. the volumetric efficiency, b. diameter and stroke of the cylinder, c. Indicated power of the compressor. **6**

5. A sling pshychrometer reads 30°C DBT and 25°C WBT. Find the humidity ratio, dew point temperature, relative humidity and the enthalpy of air. Take atmospheric pressure as 101.32 KPa.

   a. Using psychrometric chart,
   b. Using thermodynamic relations. **6**

6. In a gas turbine plant working on the Brayton cycle the air at the inlet is at 27°C, 0.1 MPa. The pressure ratio is 6.25 and the maximum temperature is 800°C. Find the ideal cycle efficiency. If the turbine and compressor efficiencies are each 80%. Find the thermal efficiency of the plant. **6**

7. Explain the compressible flow through the convergent- divergent nozzle with graphs showing pressure variation and mass flow rate along the length of the nozzle. Explain the regions of shock in it. **4**

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B

BITS, PILANI-DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006-2007

ME UC211 APPLIED THERMODYNAMICS **QUIZ2** DATE: 25-04-07

DURATION: 30 MINUTES MAXIMUM MARKS: 10 WEIGHTAGE: 10%

Name of the student: ---------- Id.: ----------

1. Show the adiabatic mixing process in a skeleton psychrometric chart and give an expression for the dry air mass ratio in terms of enthalpy ratio and sp.humidity ratio.

2. Define range and approach in a cooling tower.

3. Draw the Rankine cycle and Brayton cycle in the same T-S chart with saturation lines.

4. Draw the vapor compression refrigeration cycle in T-S coordinates with super heating (after evaporation) and under cooling (after condensation).

5. What is the use of rectifier and heat exchanger in a vapor absorption cycle?

6. Give an expression for the COP of the gas cycle refrigeration in terms of the pressure ratio of the cycle. What is the prominent application of the gas cycle refrigeration?

7. Draw the graph between pressure ratio r_p and the network for the Brayton cycle showing the optimum and maximum pressure ratios. What is the relation between optimum and maximum pressure ratios?

8 What is the effect of staged compression with inter-cooling on thermal efficiency and the network done of a gas turbine cycle?

9. Draw the vapor compression refrigeration cycle in T-S coordinates with super heating (after evaporation) and under cooling (after condensation).

10. What is the use of rectifier and heat exchanger in a vapor absorption cycle?

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ME UC211 APPLIED THERMODYNAMICS TEST 2 DATE: 8-04-07

DURATION: 50 MINUTES MAXIMUM MARKS: 20 WEIGHTAGE: 20%

Class notes, text book and thermodynamic tables are allowed

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1. Differentiate between SFC & TFC, IP & BP. **2**

2. A refrigeration plant is to develop 5 tons of refrigeration. The condenser and evaporator pressures are to be 0.8 MPa and 0.2 MPa respectively. Assuming an ideal vapor compression cycle calculate the following
   i. the refrigerant flow rate in kg/s
   ii. the volume flow rate handled by the compressor in m^3/s
   iii. the power required to drive the compressor in kW
   iv. the COP of the system

   Take the following properties for the refrigerant

   At p=0.2 MPa

   $v_g = 0.0993\ m^3/kg$, $h_g = 241.3\ kJ/kg$, $s_g = 0.9253\ kJ/kg\text{-}K$

   At P= 0.8 MPa

   $h_f = 93.42\ kJ/kg$, $t_{sat} = 33.33\ °C$

   Super heated vapor tables at 0.8 MPa

T (°C)	h (kJ/kg)	s (kJ/kg-K)
33.33	264.15	0.9066
40	273.66	0.9374

6

3. A power plant with one closed feedwater heater has a condenser temperature of 45°C, a maximum pressure of 5 MPa, and boiler exit temperature of 900°C. Extraction steam at 1 MPa to the feedwater heater condenses and is pumped up to the 5 MPa feedwater line where all the water goes to the boiler at 200°C. Find the fraction of extraction steam flow and the two specific pump work inputs. **6**

4. A test on a single cylinder 4 stroke oil engine having bore of 180 mm and stroke of 260 mm gave the following results.

   Speed = 300 rpm, brake torque = 300 N-m, IP = 15kW, oil consumption = 5 kg/h, coolant flow = 300 kg/h, rise of cooling water temperature = 30 °C, air-fuel ratio by weight = 25, exhaust gas temperature = 500 °C, room temperature = 25 °C. Specific heat of the exhaust gases = 1.0035 kJ/kg-K. Calorific value of the fuel =45200 kJ/kg. Specific heat of water = 4.2 kJ/kg-K. Draw up a heat balance sheet in kW basis. **6**

A

BITS, PILANI-DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006-2007

ME UC211 APPLIED THERMODYNAMICS QUIZ1 DATE: 07-03-07

DURATION: 30 MINUTES MAXIMUM MARKS: 10 WEIGHTAGE: 10%

Name of the student: ---------- Id.: ----------

Answers

(Write either a,b,c or d in the space provided. Change of answer and overwriting is not permitted, so be sure before entering your answer)

1	2	3	4	5	6	7	8	9	10

1. The 2 stroke cycle engine has
   a) one suction valve & one exhaust valve operated by cam
   b) one suction valve & one exhaust valve operated by 2 cams
   c) only ports covered & uncovered by piston to effect charging & exhausting
   d) no valves or ports

2. A petrol engine has compression ratio in the range of
   a) 6 to 10 b) 10 to 15
   c) 15 to 25 d) 25 to 40

3. A four stroke diesel engine runs at 1000rpm.The fuel is injected for a period of 0.0133333 seconds. The fuel injection duration expressed in degrees of crank angle is
   a) 80 b) 0.0125 c) 160 d) 60

4. Pick up the wrong statement
   a) For the same compression ratio $\eta_{Otto} > \eta_{Dual} > \eta_{Diesel}$
   b) In a dual cycle if the fuel cut off ratio equals to one then it becomes Diesel cycle.

c) If the explosion ratio(pressure ratio for constant volume heat addition) increases the efficiency of the Dual cycle increases.

d) The Stirling cycle consists of two isothermals and two isochors.

5. The efficiency of the Dual cycle with a compression ratio of 8, fuel cut-off ratio of 2.5 and explosion ratio of 3 is

a) 50.5% b) 48.5 % c) 46.5% d) 52.5%

6. Pick up the correct statement

a) Two stroke engines are more fuel efficient than the four stroke
b) The port in the two stroke engines are operated by the engine Cam shaft.
c) The speed of the Cam shaft is twice that of the engine crank shaft.
d) During scavenging process the products of combustion are removed by the fresh charge.

7. Delay period in diesel engines is

a) The time gap between the start of fuel injection and attainment of peak pressure.
b) The time gap between the start of the fuel injection and the start of combustion
c) Time gap between the start of fuel evaporation and start of combustion
d) Time gap between introduction of spark and beginning of combustion.

8. Knocking in SI engines can be controlled by

a) Super charging b) Increasing the compression ratio
c) Increasing the flame travel distance d) Using of fuel with high Octane number

9. An SI engine produces 5 KW of Brake power while consuming 2 kg/hour of fuel with a calorific value of 40MJ/kg. The brake thermal efficiency of the engine is

a) 25 % b) 0.225% c) 22.5% d) 2.5%

10 The ratio of Brake power to the indicated power of the engine is defined as

a) Brake thermal efficiency b) Mechanical efficiency
c) Frictional Efficiency d) Indicated thermal efficiency

BITS, PILANI-DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006-2007

ME UC211 APPLIED THERMODYNAMICS TEST 1 DATE: 28-02-07

DURATION: 50 MINUTES MAXIMUM MARKS: 20 WEIGHTAGE: 20%

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1. Explain the working of the diesel cycle with P-V and T-S diagrams and derive an expression for the air standard efficiency of the cycle. **6**

2. In an air standard Otto cycle the compression ratio is 7 and the compression begins at 1 bar and 313K. The heat added is 1510 kJ/kg. Find

   i) the maximum temperature and pressure of the cycle
   ii) work done per kg of air
   iii) cycle efficiency and
   iv) mean effective pressure

   Take Cv= 0.718 kJ/ kg-k and $\gamma = 1.4$ for air. **8**

3. Show that the efficiency of the Diesel cycle is lower than that of the Otto cycle for the same compression ratio. Comment why the higher efficiency of the Otto cycle compared to the Diesel cycle for the same compression ratio is only of academic interest and no practical importance. **2**

4. Find out the percentage increase in the air standard efficiency of the diesel cycle if the compression ratio changes from 5 to 8 with a constant cutoff ratio of 2.5. **4**