



10ME/AU43

Fourth Semester B.E. Degree Examination, Jan./Feb. 2021

### Applied Thermodynamics

Time: 3 hrs.

Max. Marks:100

- Note: 1. Answer any FIVE full questions, selecting at least TWO questions from each part.  
2. Use of steam table, books and charts are allowed.  
3. Assume the missing data suitably.*

#### PART – A

- 1 a. Define the terms:  
(i) Percentage of excess air (ii) Enthalpy of reaction (iii) Higher calorific value  
(iv) Adiabatic flame temperature (v) Combustion efficiency (10 Marks)
- b. The products of combustion of hydro carbon fuel of unknown composition have the following composition as measured on dry basis:  
CO<sub>2</sub> – 8.0%, CO – 0.9%, O<sub>2</sub> – 8.8%, N<sub>2</sub> – 82.3%  
Calculate: (i) Air fuel ratio (ii) Composition of fuel on mass basis  
(iii) Percentage of theoretical, air on mass basis (10 Marks)
- 2 a. With the help of P-V and T-S diagram, derive expression for efficiency of a constant pressure cycle in terms of compression ratio. Cut-off ratio and ratio's specific heats. (10 Marks)
- b. An engine working on dual combustion cycle has a pressure of 1 bar and temperature of 50°C before compression. The air is then adiabatically compressed to  $\frac{1}{15}$  of its original volume. The maximum pressure is twice the pressure at the end of isentropic compression. If the cut of ratio is 2. Find: (i) The temperature at the end of each process  
(ii) Efficiency of cycle (10 Marks)
- 3 a. With a neat sketch, explain rope brake drum dynamometer to measure torque. (04 Marks)
- b. In a test of a 4-cylinder, 4-s engine, with 75 mm bore and 100 mm stroke, the following results were obtained at full throttle and a particular constant speed with a fuel supply a 6 kg/hr.  
B.P with all cylinders firing = 15.6 KW  
B.P with 1<sup>st</sup> cylinder is cutoff = 11.1 KW  
B.P with 2<sup>nd</sup> cylinder is cutoff = 11.03 KW  
B.P with 3<sup>rd</sup> cylinder is cutoff = 10.88 KW  
B.P with 4<sup>th</sup> cylinder is cutoff = 10.66 KW  
If the calorific value of fuel is 43600 kJ/kg and clearance volume is 0.0001 m<sup>3</sup>. Calculate:  
(i) Mechanical efficiency  
(ii) Indicated thermal efficiency  
(iii) Air standard efficiency (08 Marks)
- c. Following data refers to an oil engine:  
BP = 50 KW, Mep = 6 bar Number of explosions/min = 100  
Ratio of stroke to bore = 1.5 Mechanical efficiency = 80%.  
Calculate dimensions of cylinder. (08 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

- 4 a. With a schematic diagram, explain the working of reheat vapour power cycle and deduce an expression for cycle efficiency. (08 Marks)
- b. In a regenerative vapour cycle with open feed water heater steam enters turbine at 90 bar and 350°C and expands to 9 bar where a part of steam is extracted and passed to the open feed water heater. The remaining steam expands in a turbine upto 0.1 bar. If net output of the cycle is 120 MW, find: (i) Thermal efficiency (ii) Mass flow rate. (12 Marks)

**PART - B**

- 5 a. What are the advantages of multi stage compression? (04 Marks)
- b. Derive the expression for optimum pressure ratio for minimum power of 2-stage air compressor with intercooling. (08 Marks)
- c. A single acting two stage air compressor deals with 4 m<sup>3</sup>/min of air at 1 bar and 15°C with a speed of 250 RPM. The delivery pressure is 80 bar. Assuming perfect intercooling, find the minimum power required by the compressor bore and stroke of compressor. Assume the piston speed is 3 m/s. Take mechanical efficiency 75% and volumetric efficiency 80% per stage. Assume  $n = 1.25$  for both stages neglect clearance. (08 Marks)
- 6 a. With neat sketch, explain : (i) Ram Jet (ii) Rocket propulsion (10 Marks)
- b. A gas turbine unit has a pressure ratio of 6:1 and maximum temperature in the cycle is 610°C. The isentropic efficiency of compressor and turbine are 0.8 and 0.82 respectively. Calculate the network done. The air enters the compressor at 15°C at a flow rate of 16 kg/sec. Take  $c_p = 1.005$  for compressor and  $c_p = 1.11$  for expansion. (10 Marks)
- 7 a. Define the following:
- (i) Refrigeration effect (ii) Capacity of refrigerator  
(iii) Effect of evaporator pressure (iv) Effect of condenser pressure  
(v) Coefficient of performance (10 Marks)
- b. An NH<sub>3</sub> refrigerator operates between -16°C and 50°C respectively. The vapour is dry saturated at the inlet of compressor. Calculate:
- (i) The refrigeration effect/kg  
(ii) Power per KW cooling effect  
(iii) COP.

Take  $c_p$  for NH<sub>3</sub> 3 kJ/kg°K. The properties of NH<sub>3</sub> are:

Temperature	$h_f$	$h_g$	$S_g$
-16°C	-	1424.4	5.56
50°C	421.7	1437.1	4.7696

(10 Marks)

- 8 a. Define the following:
- (i) Psychrometry (ii) Wet bulb temperature (iii) Dew point temperature  
(iv) Specific humidity (v) Relative humidity (10 Marks)
- b. In a room the DBT is 35°C and WBT is 25°C. Calculate:
- (i) Specific humidity (ii) Relative humidity (iii) Vapour density in air  
(iv) Dew point temperature (v) Enthalpy of mixture.  
Take atmospheric pressure = 1.0132 bar without using charts. (10 Marks)

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