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B. E. (Fourth Semester) Examination, Nov.-Dec. 2021

(New Scheme)

(Mech. & Automobile Branch)

APPLIED THERMODYNAMICS

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Part (a) is compulsory from each unit and carries 2 marks. Attempt any* ***two*** *from (b), (c) & (d). All questions are carrying sevem (7) marks. Use of steam table & mollier chart is permitted.*

Unit-I

1. (a) Define compression ratio. Give range of compression ratio for Petrol & diesel engine. 2

(b) Compare otto, Diesel and Dual Cycle on the basis of (i) Same compression ratio same amount of heat rejection. (ii) Same maximum pressure & same maximum temperature.

(c) Derive expression of efficiency of otto cycle, with representation on p-v and T-S plot. Also show variation of efficiencey with compression ratios.

(d) In an air standard diesel cycle with compression ratio 14, the condition of air at the start of compression stroke are 1 bar and 300 K. After addition of heat at constant pressure, the temperature rises to 2775 K. Determine the thermal efficiency of the cycle, network done per kg of air, and the mean effective pressure.

Unit-II

2. (a) Write utility of compressed air.

(b) Prove that the volumetric efficiency of a reciprocating compressor refered to ambient conditions is given by

$$\eta_{vol} = \frac{p_1 T_0}{p_0 T_1}\left[1 + C - C\left(\frac{p_2}{p_1}\right)^{1/n}\right]$$

all symbols have usual meaning.

(c) A single stage, single acting reciprocating air compressor takes in air at 1 bar, 27°C and delivers at 7 bar, volume of air entering the compressor is 5 m^3/min. Air is compressed according to the law $pv^{1.3} = C$. Calculate Isothermal efficiency and power required to drive compressor, neglect clearance volume.

(d) Show that for multistage compression, the intermediate pressure for optimum condition is to be geometric mean of its two neighbouring pressures.

Unit-III

3. (a) Write limitations of carnot cycle used in vapour power generation.

(b) With the help of Lime diagram and T-S diagram,

determine expression of efficiency for Reheat Rankine cycle.

(c) In an ideal reheat cycle, steam at 25 bar 300°C enters in to a high pressure turbine and expands to 5 bar. Steam is then reheated at this pressure in a superheater again to 300°C. After this steam expands low pressure turbine to 0.4 bar. Find thermal efficiency and specific steam consumption in kg/kWh. Neglect fluid pump work.

(d) Explain the working of Regenerative Rankine cycle with the help of suitable diagrams.

Unit-IV

4. (a) What is the utility of incorporating condenser in a steam power plant.

(b) Explain working of (i) Ejector condenser (ii) Evaporative condenser, with suitable diagram.

(c) Define (i) Vacuum efficiency (ii) Condenser efficiency, derive expression for amount of cooling water required in condensing m kg of steam.

(d) The following observation were recorded during a test on a steam condenser.

Recorded condenser vacuum	= 71 cm of Hg
Barometer reading	= 76.5 cm of Hg
Mean condenser temperature	= 34°C
Condensate collected	= 1800 kg/hr
Mass of cooling water	= 5700 kg/hr
Cooling water temperature rise	= 17.5°C

Calculate :

(i) Corrected vacuum to standard Barometer reading,

(ii) Vacuum efficiency

(iii) Condenser efficiency

(iv) State of steam entering the condenser.

Assume inlet temperature of cooling water = 8.5°C.

Unit-V

5. (a) Define Mach Number, how it changes with velocity of flowing fluid.

(b) Prove :

(i) $\frac{T_0}{T} = 1 + \frac{r-1}{2} m^2$

(ii) $\frac{p_0}{p} = \left[1 + \frac{r-1}{2} m^2\right]^{r/r-1}$

(c) A fluid flows under steady state through a convergent Divergent Nozzle, prove that

$$\frac{dA}{A} = \frac{dv}{V}\left(m^2 - 1\right).$$

(d) An aeroplane is flying at a speed of 800 kmph at a high attitude where the atmospheric air temperature is (–73°C) calculate the sonic velocity a its Mach number. Assume $R = 287$ N.m/kgK.