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Question Paper Code : 21854

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Fifth Semester

Mechanical Engineering

ME 2301/ME 51/ME 1351 A/10122 ME 402 — THERMAL ENGINEERING

(Common to Sixth Semester Mechanical Engineering (sandwich))

(Regulations 2008/2010)

(Common to PTME 2301 – Thermal Engineering for B.E. (Part-Time) Mechanical Engineering Fourth Semester – Regulations 2009)

Time : Three hours Maximum : 100 marks

Use of approved thermodynamics tables, Mollier diagram, Psychrometric chart and Refrigerant property tables permitted in the Examinations)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State any four assumptions through which a mechanical cycle is modelled into an air standard cycle?

2. Plot the general diesel cycle efficiency as a function of compression ratio for various cut off ratios.

3. List the main parts of a lubrication system.

4. What is known as pre ignition? State its effect.

5. For what purposes steam nozzles are used?

6. Write the advantages of velocity compounding in Impulse type steam turbines.

7. In reciprocating compressors, why the free air delivered volume is lesser than compressor displacement volume?

8. Define compressor efficiency.

9. What is purging?

10. What is stack effect or chimney?

PART B — (5 × 16 = 80 marks)

11. (a) The blade speed of a single ring of an impulse turbine is 300 m/s and the nozzle angle is 20°. The isentropic heat drop is 473 kJ/kg and the nozzle efficiency is 0.85. Given that the blade velocity co efficient is 0.7 and the blades are symmetrical, draw the vector diagrams and calculate for a mass flow of 1 kg/s.

(i) Axial thrust on the blading

(ii) Steam consumption per B.P hour if the mechanical efficiency is 90%

(iii) Blade efficiency, stage efficiency and maximum blade efficiency

(iv) Heat equivalent of the friction of blading. (16)

Or

(b) Determine the throat area, exit area and exit velocity for a steam nozzle to pass a mass flow of 0.2 kg/s when inlet conditions are 10 bar and 250°C and the final pressure is 2 bar. Assume expansion is isentropic and that the inlet velocity is negligible. Use $pV^{1.3}$ = Constant. Do not calculate from h-s chart. (16)

12. (a) Derive an expression for air standard efficiency and mean effective pressure of Otto cycle with relevant sketches. (16)

Or

(b) The swept volume of a diesel engine working on dual cycle is 0.0053 m^3 and clearance volume is 0.00035 m^3. The maximum pressure is 15 bar. Fuel injection ends at 5% of the stroke. The temperature and pressure at the start of the compression are 80°C and 0.9 bar. Determine the air standard efficiency of the cycle. Take γ for air = 1.4. (16)

13. (a) A four stroke SI engine has a swept volume of 925 cm^3 and a compression ratio of 15 : 1. The indicated efficiency is 65% of the corresponding ideal air standard Otto cycle. At 8500 rpm the mechanical efficiency is 90% and the volumetric efficiency is 93%. The air to fuel ratio (by mass) is 20:1, and the calorific value of the fuel is 44 MJ kg^{-1}. The air is inducted at 20°C and 1 bar. Calculate

(i) the arbitrary overall efficiency and the sfc

(ii) the air mass flow rate, power output and bmep. (16)

Or

(b) (i) Compare SI and CI engines. (8)

(ii) Compare two stroke and four stroke engines. (8)

14. (a) A single acting, single cylinder reciprocating air compressor has a cylinder diameter of 200 mm and a stroke of 300 mm. Air enters the cylinder at 1 bar, 27°C. It is then compressed polytropically to 8 bar according to the law $pV^{1.3}$ = constant. If the speed of the compressor is 250 rpm, calculate the mass of air compressed per minute, and the power required in kW for driving the compressor. (16)

Or

(b) (i) Describe the methods of improving isothermal efficiency of a reciprocating air compressor. (10)

(ii) List the parameters which are all affecting the overall volumetric efficiency of a reciprocating air compressor. (6)

15. (a) The sling psycrometer in a laboratory test recorded the following readings. DBT = 35°C and WBT = 25° C. Calculate

(i) specific humidity

(ii) relative humidity

(iii) vapour density in air

(iv) dew point temperature

(v) enthalpy of mixture per kg of dry air.

Take atm. Pressure as = 1.0132 bar. (16)

Or

(b) A Freon -12 refrigerator producing a cooling effect of 20 kJ/s operates on a simple cycle with pressure limits of 1.509 and 9.607 bar. The vapour leaves the evaporator dry saturated and there is no under cooling. Determine the power required by the machine. If the compressor operates at 300 rpm and has a clearance volume of 3% of stroke volume, determine the piston displacement of the compressor. For compressor assume that the expansion follows $pV^{1.3}$ = constant. Given : (16)

Temperature °C	p_s bar	v_g m^3/kg	Enthalpy kJ/kg h_f	h_g	Entropy kJ/kgK s_f	s_g	Specific heat kJ/kgK
–20	1.509	0.1088	17.8	178.61	0.073	0.7082	–
40	9.607	–	74.53	203.05	0.2716	0.682	0.747