Model Question Paper-1 with effect from 2019-20 (CBCS Scheme)

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Fourth Semester B.E. Degree Examination

Applied Thermodynamics

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.
02. Use of thermodynamic data hand book is permitted.

		Module -1	*Bloom's Taxonomy Level	Marks
Q.01	a	Derive an expression for air standard efficiency of an Otto cycle, stating the assumptions made.	L2	08
	b	A diesel engine is operating on air standard diesel cycle has 20 cm bore and 30 cm stroke. The clearance volume is $4.2X10^{-4}$ m^3. The fuel is injected at constant pressure for 5% of the stroke, calculate the air standard efficiency. If the cut off is delayed from 5% to 8%, what will be the effect on efficiency?	L3	12
		OR		
Q.02	a	Explain briefly: (i) Morse Test and (ii) Heat balance sheet	L2	08
	b	A test on two stroke IC engine gave the following results at full load. Speed = 350 rpm; Net brake load =650 N; Indicated m.e.p = 3 bar; Fuel consumption $=1.1X10^{-3}$ kg/s; Jacket water temperature flow rate = 0.138 kg/s; Jacket water temperature at inlet = 20° C; Jacket water temperature at outlet = 40°C; Room temperature = 20°C; Exhaust gas temperature = 400°C; Air used per kg of fuel = 32 kg; Cylinder diameter = 22 cm; Stroke = 30 cm; Brake drum circumference = 314 cm; Calorific value of fuel = 43 MJ/kg; Specific heat of exhaust gases = 1.0 kJ/kg K. Determine (i) Mechanical efficiency (ii) Brake mean effective pressure. Draw a heat balance sheet including heat equivalent of BP, heat loss due to friction, heat carried away by exhaust gases and unaccounted heat loss.	L3	12
		Module-2		
Q. 03	a	With a neat sketch, explain the working (i) Ram jet and (ii) Turbo jet	L2	8
	b	A gas turbine working on Brayton cycle has a regenerator of 75% effectiveness. Air at inlet to compressor is at 100 kPa and 27°C and the maximum cycle temperature is limited to 900°C. The pressure ratio used is 6. If the turbine efficiency = 80%, and compressor efficiency = 82%, find (i) Percentage increase of cycle efficiency due to regeneration and (ii) Work ratio.	L3	12
		OR		
Q.04	a	Explain the methods of improving the efficiency and specific power output of a simple gas turbine cycle.	L2	8
	b	In an open cycle constant pressure gas turbine, air enters the compressor at 1.0 bar and 27°C. The pressure of air after the compression is 4.0 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air fuel ratio used is 80:1. Find the power required and thermal efficiency of the cycle if the flow rate of air is 5 kg/s.	L3	12
		Module-3		
Q. 05	a	Sketch the flow diagram and corresponding T – s diagram of a reheat vapor power cycle and derive an expression for the reheat cycle efficiency.	L2	8
	b	A cyclic steam power plant is to be designed at turbine inlet temperature of 360°C and an exhaust pressure of 0.08 bar. After isentropic expansion of steam in the turbine, the moisture content at the turbine exhaust is not exceeding 15%.	L3	12

<table>
<tr><td></td><td></td><td>Determine: (i) The greatest allowable steam pressure at the turbine inlet (ii) Efficiency of the Rankine cycle and (iii) Specific steam consumption in kg/kW-hr</td><td></td><td></td></tr>
<tr><td colspan="3">OR</td><td></td><td></td></tr>
<tr><td>Q. 06</td><td>a</td><td>With the help of a schematic and T-s diagram, explain the working of an ideal regenerative vapor cycle and derive an expression for the overall efficiency.</td><td>L2</td><td>8</td></tr>
<tr><td></td><td>b</td><td>Steam enters the first stage of a reheat Rankine cycle at 8 MPa, 500°C and expands to 700 kPa. It is then reheated to 450°C before entering a second stage turbine, where it expands to 0.08 bar. The net power output is 100 MW. Determine: (i) Thermal efficiency of the cycle (ii) Steam flow rate (iii) Quality of steam at the end of expansion, and (iv) Total heat rejected in the condenser in MW.</td><td>L3</td><td>12</td></tr>
<tr><td colspan="3">Module-4</td><td></td><td></td></tr>
<tr><td>Q. 07</td><td>a</td><td>Define the following: (i) Refrigerating effect (ii) Ton of refrigeration (iii) Ice making capacity and (iv) Relative COP</td><td>L1</td><td>4</td></tr>
<tr><td></td><td>b</td><td>State the differences between vapor compression refrigeration and vapor absorption refrigeration systems.</td><td>L1</td><td>6</td></tr>
<tr><td></td><td>c</td><td>A vapor compression refrigeration system of 5.0 kW cooling capacity operates between -10°C and 30°C. The enthalpy of refrigerant vapor after compression is 370 kJ/kg. Find the COP, refrigerating effect, mass flow rate of the refrigerant and the compressor power. Use the properties of refrigerant in the table given below.
<table>
<tr><th>Temp (°C)</th><th>Pressure (bar)</th><th>h_f (kJ/kg)</th><th>h_g (kJ/kg)</th><th>s_f (kJ/kgK)</th><th>s_g (kJ/kgK)</th></tr>
<tr><td>-10</td><td>2.26</td><td>190</td><td>345</td><td>0.95</td><td>1.50</td></tr>
<tr><td>30</td><td>7.50</td><td>220</td><td>363</td><td>1.10</td><td>1.45</td></tr>
</table></td><td>L3</td><td>10</td></tr>
<tr><td colspan="3">OR</td><td></td><td></td></tr>
<tr><td>Q. 08</td><td>a</td><td>Define the following: (i) Dry bulb temperature (ii) Specific humidity (iii) Relative humidity, and (iv) Wet bulb temperature</td><td>L1</td><td>4</td></tr>
<tr><td></td><td>b</td><td>Show the following processes on Psychrometric chart.
(i) Sensible heating
(ii) Sensible cooling
(iii) Cooling and Dehumidification</td><td>L1</td><td>6</td></tr>
<tr><td></td><td>c</td><td>`A room measures 5mX 5mX3m. It contains air at 25°C and 100 kPa at a relative humidity of 75 percent. Determine (i) the partial pressure of the dry air (ii) the specific humidity (iii) the enthalpy per unit mass of the dry air, and (iv) the masses of the dry air and water vapor in the room.</td><td>L3</td><td>10</td></tr>
<tr><td colspan="3">Module-5</td><td></td><td></td></tr>
<tr><td>Q. 09</td><td>a</td><td>Obtain an expression for the volumetric efficiency of a single stage air compressor in terms of the pressure ratio, the clearance ratio and the index of expansion and explain the effect of clearance on the volumetric efficiency.</td><td>L2</td><td>8</td></tr>
<tr><td></td><td>b</td><td>An air compressor cylinder has 15.0 cm bore and 15.0 cm stroke and clearance is 5% of the stroke. The machine operates between 1.0 bar and 5.0 bar. The polytropic index is 1.3 for both compression and expansion processes. The compressor runs at 720 rpm with a mechanical efficiency of 85%. Find the following: (i) Cylinder volume at each corner of idealized indicator diagram in cm^3, and (ii) Power required to drive the compressor.</td><td>L3</td><td>12</td></tr>
<tr><td colspan="3">OR</td><td></td><td></td></tr>
<tr><td>Q. 10</td><td>a</td><td>Briefly explain different types of nozzles.</td><td>L2</td><td>8</td></tr>
<tr><td></td><td>b</td><td>Steam enters a converging-diverging nozzle at 2.0 MPa and 400°C with</td><td></td><td></td></tr>
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		negligible velocity and a mass flow rate of 2.5 kg/s, and it exits at a pressure of 300 kPa. The flow is isentropic between the nozzle entrance and throat, and the overall nozzle efficiency is 93 percent. Determine (a) Throat velocity (ii) Throat area (iii) The enthalpy of steam at actual exit state (iv) Exit velocity and (v) Exit area.	L3	12