Q.6	i.	An air plane travels at a Mach number of 1.5 at an elevation where the temperature is -37°C. Determine the velocity of plane.	**2**
	ii.	In a convergent-divergent nozzle the steam enters at 15 bar and 300°C and leaves at a pressure of 2 bar. The inlet velocity of the steam is 150 m/s. Find the required throat area and exit area of the nozzle. Take mass flow rate of steam as 1 kg/s and nozzle efficiency as 93%. Assume $C_{p\text{-steam}}$ = 2.4 kJ/kgK.	**8**
OR	iii.	Write short notes on: (a) Mach Angle and Mach cone, (b) Supersonic diffuser	**8**

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Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No.....

Faculty of Engineering

End Sem (Even) Examination May-2019

ME3CO09 Energy Conversion - I

Programme: B.Tech. Branch/Specialisation: ME

Duration: 3 Hrs. **Maximum Marks: 60**

Note: (a) All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.
(b) Use of steam tables is permitted.

Q.1	i.	The function of a fusible plug is to (a) Superheat the steam (b) Extinguish the fire (c) Maintain constant temperature (d) Increase flue gas temperature	**1**
	ii.	The natural draught is produced by (a) Fan before the furnace (b) Air preheater (c) Chimney height (d) Compressor	**1**
	iii.	In regenerative Rankine cycle, the feed water is heated by (a) Exhaust steam (b) Condensed water (c) Bled off steam (d) Fresh steam	**1**
	iv.	The ratio of pump work to turbine work is known as (a) Back work ratio (b) Heat rate of boiler (c) Rankine efficiency (d) Isentropic efficiency	**1**
	v.	In a condenser (a) The temperature of hot fluid increases (b) The temperature of cold fluid decreases (c) The temperature of hot fluid remains constant (d) None of these	**1**
	vi.	Air leakage in the condenser reduces (a) Friction (b) Turbine output (c) Velocity (d) Vibration	**1**

P.T.O.

vii. For isothermal compression in a compressor, it should run at **1**
(a) Very high speed
(b) Very low speed
(c) Speed doesn't matter
(d) First at low speed then at high speed

viii. The isothermal efficiency of a reciprocating air compressor can be improved by the use of **1**
(a) Water jacketing (b) External fins
(c) Intercooler (d) All of these

ix. Nozzle efficiency is defined as the **1**
(a) Ratio of actual enthalpy drop to isentropic enthalpy drop
(b) Ratio of isentropic enthalpy drop to actual enthalpy drop
(c) Product of isentropic enthalpy drop, and actual enthalpy drop
(d) None of these

x. Flow of fluid is called transonic when **1**
(a) M = 1 (b) M < 1 (c) M > 1 (d) 0.8 < M < 1.2

Q.2 i. Draw a well labelled diagram of La Mont Boiler. **3**

ii. A 40 cm high chimney is discharging flue gases at 350°C, when the ambient temperature is 30°C. The quantity of air supplied is 18 kg per kg of fuel burnt. Determine: **7**
(a) Draught produced in mm of water,
(b) Equivalent draught in metres of hot gas column.
(c) Efficiency of chimney, if minimum temperature of artificial draught is 150°C and c_p of flue gases is 1.005 kJ/kgK.

OR iii. A boiler generates 8 kg of steam per kg of fuel burnt at a pressure of 12 bar from feed water entering at 80°C. The boiler is 75% efficient and its factor of evaporation is 1.15. Calculate: **7**
(a) Degree of superheat of steam generated
(b) Calorific value of fuel.
Take c_p of superheated steam as 2.3 kJ/kgK.

Q.3 i. What is the physical significance of isentropic efficiency of a steam turbine? What does its value suggest? **2**

ii. In a Rankine cycle, the steam at inlet to a turbine is dry saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Calculate: **8**
(a) Pump work (b) Turbine work
(c) Rankine efficiency (d) Condenser heat flow
Assume mass flow rate of 9.5 kg/s.

OR iii. Explain the following; with the help of schematic diagram, T-s plot and thermal analysis of the cycle: **8**
(a) Reheat Rankine cycle (b) Regenerative Rankine cycle

Q.4 i. Differentiate between Jet Condensers and Surface Condensers. **3**

ii. A vacuum of 710 mm of Hg was recorded in a condenser when the barometer reads 755 mm of Hg. The temperature of the condensate was 25°C. Calculate the pressure of steam and air in the condenser assuming their specific volumes to be same. Also calculate mass of air per kg of steam and vacuum efficiency. **7**

OR iii. Explain the working and construction of an Induced-draft cooling tower with the help of labelled diagram. Also state its advantages over Natural- draft cooling tower. **7**

Q.5 i. Why does a reciprocating compressor termed as a positive displacement machine? **2**

ii. 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 using index of compression 1.3. If the speed of compressor is 250 rpm, calculate the mass of air compressed per minute, and power required in kW. Assume negligible clearance volume. **8**

OR iii. An ideal single-stage, single acting reciprocating air compressor has a displacement volume of 14 litres and a clearance volume of 0.7 litres. It receives air at a pressure of 1 bar and delivers at 7 bar. For compression, $pv^{1.3}=C$ and re-expansion is adiabatic. Calculate the net indicated work of a cycle. **8**

Marking Scheme
ME3CO09 Energy Conversion - I

Q.1 i. The function of a fusible plug is to **1**
(b) Extinguish the fire

ii. The natural draught is produced by **1**
(c) Chimney height

iii. In regenerative Rankine cycle, the feed water is heated by **1**
(c) Bled off steam

iv. The ratio of pump work to turbine work is known as **1**
(a) Back work ratio

v. In a condenser **1**
(c) The temperature of hot fluid remains constant

vi. Air leakage in the condenser reduces **1**
(b) Turbine output

vii. For isothermal compression in a compressor, it should run at **1**
(b) Very low speed

viii. The isothermal efficiency of a reciprocating air compressor can be improved by the use of **1**
(d) All of these

ix. Nozzle efficiency is defined as the **1**
(a) Ratio of actual enthalpy drop to isentropic enthalpy drop

x. Flow of fluid is called transonic when **1**
(d) $0.8 < M < 1.2$

Q.2 i. Draw a well labelled diagram of La Mont Boiler. **3**
With 1-4 labelled parts 1 mark
5-8 parts + 1 mark
9+ parts + 1 mark

ii. Draught produced in mm of water = 0.2267 mm 3 marks **7**
Equivalent draught in metres of hot gas column = 0.37915 m 2 marks
Efficiency of chimney= 0.00185 2 marks
Step marking should be given

OR iii. Degree of superheat= 62.3°C 4 marks **7**
CV of fuel= 27661.22 kJ/kg 3 marks
Step marking should be given

Q.3 i. Physical significance of isentropic efficiency of a steam turbine **2**

ii. Pump work= 33.63 kW 1 mark **8**
T-S / H-S diagram 1 mark
Turbine work= 7482.58 kW 2 marks
Efficiency = 0.3078 2 marks
$Q_{condenser}$= 16750 kW 2 marks
Step marking should be given

OR iii. Explain the following; with the help of schematic diagram, T-s plot and thermal analysis of the cycle: **8**
(a) Reheat Rankine cycle
Diagram 1 mark
T-s plot 1 mark
Analysis and theory 2 marks
(b) Regenerative Rankine cycle
Diagram 1 mark
T-s plot 1 mark
Analysis and theory 2 marks

Q.4 i. Differentiate between Jet Condensers and Surface Condensers. **3**
0.5 mark for each point (0.5 mark * 6)

ii. Calculate mass of air per kg of steam and vacuum efficiency. **7**
P_{steam}= 3.17 kPa 2 marks
P_{air} = 2.83 kPa 2 marks
m_a= 0.0143 kg/kg of steam 2 marks
η_{vacuum}= 0.964 1 mark
Step marking should be given

OR iii. Induced-draft cooling tower **7**
Explanation 3 marks
Diagram 3 marks
Advantages 1 mark

Q.5 i. Reciprocating compressor termed as a positive displacement machine **2**

ii. Assume negligible clearance volume. **8**
$\dot{m}_a$ = 2.74 kg/min 4 marks
Power = 10.49 kW 4 marks
Step marking should be given

OR iii. Calculate the net indicated work of a cycle. **8**
PV diagram 2 marks
Numerical 6 mrks

Q.6 i. Determine the velocity of plane. **2**

ii. Find the required throat area and exit area of the nozzle. **8**
Throat area = 585.5 mm^2 4 marks
Exit area = 882 mm^2 4 marks

OR iii. Write short notes on: **8**
(a) Mach Angle and Mach cone, 4 marks
(b) Supersonic diffuser 4 marks

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