Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem (Even) Examination May-2022

ME3CO09 Energy Conversion -I

Programme: B.Tech. Branch/Specialisation: Mechanical

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

Note: 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. Use of Steam Table is permitted in the examination hall.

Q.1 i. Which one of these is a once through boiler? **1**

(a) Cochran Boiler (b) Subcritical Boiler

(c) Supercritical boiler (d) Either (b) or (c)

ii. A pressure cooker can be considered as a boiler if- **1**

(a) Pressure above 1atm (b) Volume above 22.7 L

(c) Either (a) or (b) (d) Both (a) and (b)

iii. Thermal cycle with maximum efficiency for steam power plants. **1**

(a) Carnot Cycle (b) Brayton cycle

(c) Rankine Cycle (d) Both (a) and (b)

iv. Steam expansion in the turbine is a- **1**

(a) Adiabatic process (b) Isentropic Process

(c) Reversible Adiabatic process (d) Both (b) and (c)

v. In a high-level jet condenser, condenser shell is installed at a height of- **1**

(a) More than 5.5 m (b) More than 10.33 m

(c) Less than 10.33 m (d) None of these

vi. Air leakage into the condenser reduces- **1**

(a) Turbine output (b) Cooling capacity

(c) Life of condenser (d) All of these

vii. For Isothermal compression in a compressor, the compressor should run at- **1**

(a) Very high-speed (b) Very slow speed

(c) Constant speed (d) None of these

P.T.O.

viii. Usually, the index of actual compression is- **1**
(a) Near to 1 (b) 1.3 to 1.4 (c) 1.1 to 1.3 (d) 1.4 to 1.6

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

x. For supersaturated flow in the nozzle, the discharge is- **1**
(a) Increases (b) Decreases
(c) Remains constant (d) None of these

Q.2 i. Define equivalent evaporation and factor of evaporation with formula indicating proper notations. **4**

ii. A boiler uses 16 kg of air per kg of fuel, when the fuel consumption is at the rate of 1800 kg/h. Actual draught required is 20mm of Water when all losses are considered. The surrounding air temperature is 27^0C and the flue-gas temperature is 277 ^{0}C. Determine the chimney height and its diameter if actual velocity of the flue gases is 0.35 times the theoretical velocity due to roughness of interior surfaces of the chimney. **6**

OR iii. Calculate the equivalent evaporation from and at 100 ^{0}C, for a boiler, which receives water at 60 ^{0}C and produces steam at 1.5 MPa and 300^0C.The steam generation rate is 16000 kg/h. Coal is burnt at the rate of 1800 kg/h. The calorific value of coal is 34750 kJ/kg. Also calculate the thermal efficiency of the boiler. **6**
If the thermal efficiency of the boiler increases by 5% due to use of an economiser, find the saving in coal consumption per hour.

Q.3 i. Compare Carnot cycle with Rankine cycle. Any two significant points. **2**

ii. A steam power plant operates on a theoretical reheat cycle. The steam from boiler at 150 bar and 550 ^{0}C expands through high pressure turbine. It is reheated at constant pressure of 40 bar to 550 ^{0}C and expands through the low-pressure turbine to a condenser pressure of 0.1 bar. Draw T-s and h-s diagrams and find **8**
(a) Quality of steam at turbine exhaust
(b) Thermal efficiency of the cycle
(c) Steam rate in kg/kWh

OR iii. Steam enters the turbine at 3 MPa, 350 ^{0}C and is condensed in the condenser at a pressure of 75 kPa. Draw T-s diagram and determine thermal efficiency of steam power plant, back work ratio, work ratio and specific steam consumption in Kg/kWh. **8**

Q.4 i. With the help of block diagram discuss the functioning of condenser and cooling tower. **4**

ii. With neat sketch and levelling explain types of jet condensers. **6**

OR iii. Following data refers to the test of surface condenser of a steam turbine. Absolute pressure of steam entering condenser is 5.628 kPa, temperature of condensate leaving the condenser is 32 ^{0}C, inlet and outlet temperature of cooling water is 15 ^{0}C and 30 ^{0}C respectively with mass of cooling water per kg of steam is 32 kg. Assuming that all the heat lost by the exhaust steam is taken up by the circulating water, determine the dryness fraction of the steam as it enters the condenser. **6**

Q.5 i. Classify compressors with the help of tree structure. **4**

ii. Derive expression for Indicated work for a single acting reciprocating compressor without clearance. **6**

OR iii. A single acting, single cylinder reciprocating air compressor is compressing 20 kg/min. of air from 110 kPa, 30^0C to 600 kPa and delivers it to a receiver. Law of compression $PV^{1.25}$ = constant. Mechanical efficiency is 80%. **6**
Find the power input to compressor, neglecting losses due to clearance, leakages, and cooling.

Q.6 Attempt any two:

i. Describe mach number and mach cone. **5**

ii. Derive the expression for discharge through an isentropic steam nozzle. **5**

iii. Discuss the significance of critical pressure ratio for a steam nozzle. **5**

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Marking Scheme
ME3CO09 Energy Conversion -I

Q.1	i.	Which one of these is a once through boiler? (c) Supercritical boiler		**1**
	ii.	A pressure cooker can be considered as a boiler if- (b) Volume above 22.7 L		**1**
	iii.	Thermal cycle with maximum efficiency for steam power plants. (c) Rankine Cycle		**1**
	iv.	Steam expansion in the turbine is a- (d) Both (b) and (c)		**1**
	v.	In a high-level jet condenser, condenser shell is installed at a height of- (b) More than 10.33 m		**1**
	vi.	Air leakage into the condenser reduces- (d) All of these		**1**
	vii.	For Isothermal compression in a compressor, the compressor should run at- (b) Very slow speed		**1**
	viii.	Usually, the index of actual compression is- (c) 1.1 to 1.3		**1**
	ix.	Flow of fluid is transonic when- (d) 0.8 > M > 1.2		**1**
	x.	For supersaturated flow in the nozzle, the discharge is- (a) Increases		**1**
Q.2	i.	Definition with formula of equivalent evaporation Definition with formula of factor of evaporation	2 marks 2 marks	**4**
	ii.	Determine the chimney height and its diameter Height of Chimney H=40.43 m Diameter D=1.375 m	 3 marks 3 marks	**6**
OR	iii.	Calculate the equivalent evaporation EE=10.1 kg/kg of fuel thermal efficiency of the boiler Efficiency η=71.31% Saving in coal consumption per hour Coal Saving=118kg/h	 2 marks 2 marks 2 marks	**6**
Q.3	i.	Compare Carnot cycle with Rankine cycle Any two points with diagram 1 mark for each	 (1 mark * 2)	**2**
	ii.	T-s and h-s diagrams 1 mark for each (1 mark * 2) (a) Quality of steam at turbine exhaust, x=0.88 (b) Thermal efficiency of the cycle, η=43.8% (c) Steam rate, ssc=2.19 kg/kWh	2 marks 2 marks 2 marks 2 marks	**8**
OR	iii.	Thermal efficiency of steam power plant η=26% Back work ratio, r_{bw}=0.0042 Work ratio, r_w =0.995 Specific steam consumption in Kg/kWh, SSC=5.06	2 marks 2 marks 2 marks	**8**
Q.4	i.	Block diagram Functioning of condenser Functioning of cooling tower	2 marks 1 mark 1 mark	**4**
	ii.	Types of jet condensers Low-level High-level Ejector condenser	 2 marks 2 marks 2 marks	**6**
OR	iii.	Heat balance equation/statement Calculation and Dryness fraction x=0.826	2 marks 4 marks	**6**
Q.5	i.	Compressors with the help of tree structure.		**4**
	ii.	Indicated work for a single acting reciprocating compressor without clearance. P-V diagram Equations and Derivation	 2 marks 4 marks	**6**
OR	iii.	Find the power input to compressor, neglecting losses due to clearance, leakages, and cooling. Indicated Power=58.55 kW Power input BP=73.18 kW	 3 marks 3 marks	**6**
Q.6		Attempt any two:		
	i.	Describe mach number mach cone Definition Diagram	2 marks 2 marks 1 mark	**5**
	ii.	Derivation for discharge through an isentropic steam nozzle As per explanation		**5**
	iii.	Significance of critical pressure ratio for a steam nozzle Graph Discussion	 2 marks 3 marks	**5**

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