PAPER ID-421490

Roll No: | | | | | | | | | | | | | |

BTECH
(SEM IV) THEORY EXAMINATION 2021-22
APPLIED THERMODYNAMICS

Time: 3 Hours ***Total Marks: 100***

Note: Attempt all Sections. If you require any missing data, then choose suitably.

SECTION A

1. Attempt *all* questions in brief. 2*10 = 20

Qno	Questions	CO
(a)	Define adiabatic flame temperature.	1
(b)	Define Stoichiometric air and Excess air.	1
(c)	Define Enthalpy of formation.	2
(d)	Discuss limitations of Carnot vapour power cycle and explain how Rankine cycle helps in overcoming them.	2
(e)	Differentiate between Boiler mountings and Boiler accessories.	3
(f)	Differentiate between Jet condensers and Surface condensers.	3
(g)	Define Degree of reaction of steam turbine.	4
(h)	Differentiate between Impulse and Reaction Turbines.	4
(i)	Explain Rocket Propulsion.	5
(j)	Classify the jet propulsion engines.	5

SECTION B

2. Attempt any *three* of the following: 10*3 = 30

Qno	Questions	CO
(a)	Derive an expression for air standard efficiency of Otto cycle in terms of compression ratio.	1
(b)	A steam turbine plant operates on Rankine cycle with steam entering turbine at 40 bar, 350ºC and leaving at 0.05 bar. Steam leaving turbine condenses to saturated liquid inside condenser. Feed pump pumps saturated liquid into boiler. Determine the net work per kg of steam and the cycle efficiency. Assuming all processes to be ideal. Also show cycle on T-s diagram.	2
(c)	Draw any water tube boiler and explain the functioning of following mounting and accessories- safety valves, and Fusible plug, Feed check valve, Superheater, Economizer and Air-preheater.	3
(d)	Define the blade efficiency. Derive an expression for maximum blade efficiency for an impulse turbine. $(\eta_{blade})_{max} = \cos^2 \alpha$	4
(e)	Derive the expression for volumetric efficiency of reciprocating compressor in terms of pressure ratio and clearance ratio. A 2-stage compressor with perfect intercooling delivers 5 Kg/min air at 16 bar. Inlet conditions are 1 bar and 300 K. The index of compression is 1.3. Determine the power required to run compressor and isothermal efficiency of compressor.	5

SECTION C

3. Attempt any *one* part of the following: 10*1 = 10

Qno	Questions	CO
(a)	The percentage composition of a fuel on mass basis is as follows: C=90% , H_2 = 3.5%, O_2 =1% , S=0.5% and ash=5%	1

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	Calculate the i) minimum air required for complete combustion of 1kg of fuel ii) composition of dry flue gases on mass basis if 50 % excess air is supplied.	
(b)	Discuss any 4 differences between Otto cycle and Diesel cycle. Determine thermal efficiency and mean effective pressure of thermodynamic cycle used by a 4-stroke petrol engine. Details of cycle are as follows. Compression ratio= 7, Initial state=100 KPa and 90ºC Swept volume = 0.1 m^3 Heat added to cycle at constant volume = 100 KJ/cycle.	1

4. Attempt any *one* part of the following: 10 *1 = 10

Qno	Questions	CO
(a)	Discuss the effects of Regeneration, Superheating, Reheating on Rankine cycle with the help of neat sketches.	2
(b)	In a combined gas turbine steam turbine power plant , the exhaust gas from the open cycle gas turbine is supply gas to steam generator of steam cycle at which additional fuel is burnt in the gas. The pressure ratio for the gas turbine is 7, air inlet temperature is 20ºC and maximum cycle temperature is 750ºC.Combustion of additional fuel raise the gas temperature to 750ºC and gas leaves the steam generator at 100ºC.The steam is supplied to the turbine at 50 bar, 600ºC and condenser pressure is 0.1 bar. The total power output of plant is 200 MW. The calorific value of fuel burnt is 43.3 MJ/Kg. Determine the following- Power output of gas turbine and steam turbine, Thermal efficiency of combined plant. For combustion gases- C_P = 1.11 KJ/Kg, γ= 1.33 . For air- C_P = 1.005 KJ/Kg, γ = 1.4	2

5. Attempt any *one* part of the following: 10*1 = 10

Qno	Questions	CO
(a)	Demonstrate the following - Equivalent evaporation, Effects of air leakage on condenser performance, Boiler Draught , Difference between Natural and Forced Draught .	3
(b)	The following readings were taken during a test on surface condenser Mean condenser temperature = 35ºC, Hot well temperature = 30ºC, Condenser vaccum = 69 cm Hg, Barometer reading = 76 cm Hg, Condensate collected = 16 Kg/ min, Cooling water enters at 20ºC and leaves at 32.5ºC , Flow rate = 37500Kg/h Calculate the following- Mass of air present per cubic metre of condenser, Quality of steam at condenser inlet, Vaccum Efficiency, Condenser efficiency	3

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6. Attempt any *one* part of the following: 10*1 = 10

Qno	Questions	CO
(a)	Define critical pressure ratio for nozzle of the steam turbine. Obtain analytically its value in terms of the index of expansion.	4
(b)	A stage of a steam turbine with Parsons' blade delivers a dry saturated steam at 2.7 bar from fixed blade at 90m/sec. The blade height is 40 mm and moving blade exit angle is 20º. The flow components of velocity is ¾ blade velocity at inlet condition. Steam is supplied at rate of 9000 Kg/hour. The blade effect of blade thickness can be neglected .The specific volume of steam at 2.7 bar is 0.6686 m^3/Kg. Determine the following- Rotational speed in rpm, power developed, blade efficiency.	4

7. Attempt any *one* part of the following: 10*1 = 10

Qno	Questions	CO
(a)	A turbojet flying at 800 Km/h has an air flow rate of 50 Kg/s. The enthalpy drop across the nozzle is 200 KJ/Kg. The air-fuel ratio is 80 and calorific value of fuel is 41 MJ/kg. Estimate propulsive power, Thrust power, propulsive efficiency, thermal efficiency and overall efficiency of the unit.	5
(b)	Explain perfect intercooling in brayton cycle. A Brayton cycle has a pressure ratio of 4. Inlet conditions are 1 bar, 27ºC. Find air flow required for 100 KW power output if maximum temperature in the cycle is 1000ºC. Take γ =1.4 and C_p= 1 KJ/Kg.K	5