PAPER ID-411526

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

BTECH
(SEM IV) THEORY EXAMINATION 2023-24
APPLIED THERMODYNAMICS

TIME: 3 HRS **M.MARKS: 70**

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

SECTION A

1. Attempt *all* questions in brief. **2 x 7 = 14**

a.	Differentiate between S.I. engine and C.I. engine.
b.	What are the limitations of Carnot vapour power cycle?
c.	What do you mean by endothermic and exothermic reactions?
d.	What is the function of an air pre-heater in a boiler system?
e.	Differentiate between surface condenser and jet condenser.
f.	What factors influence the efficiency of a nozzle?
g.	What is stage efficiency?

SECTION B

2. Attempt any *three* of the following: **7 x 3 = 21**

a.	Derive expression for efficiency of Otto cycle.
b.	Compare performance of regenerative cycle with simple Rankine cycle.
c.	What are the different types of condensers used in power plants, and what are their key features?
d.	Obtain the condition for maximum blade efficiency in single stage impulse turbine. Also, show how this efficiency varies with blade speed to steam velocity ratio.
e.	What is the purpose of reheat in a gas turbine cycle, and how does it affect thermal efficiency?

SECTION C

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

a.	A four-stroke SI engine has the compression ratio of 6 and swept volume of 0.15 m3. Pressure and temperature at the beginning of compression are 98 kPa and 60ºC. Determine the pressure, volume and temperatures at all salient points if heat supplied to it is 150 kJ/kg. Also find out entropy change, work done, efficiency and mean effective pressure of cycle assuming cp = 1 kJ/kg · K, cv = 0.71 kJ/kg · K. Also, plot the cycle on T-S diagram.
b.	What is the principle of operation of a turbocharger, and how does it improve engine performance?

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

a.	A steam turbine plant operates on Rankine cycle with steam entering turbine at 40 bars, 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 network per kg of steam and the cycle efficiency assuming all processes ideal. Also show cycle on T-s diagram. Also, determine pump work per kg of steam considering linear variation of specific volume.
b.	During Orsat analysis of the combustion products of an engine running on diesel ($C_{12}H_{26}$) the CO_2 and O_2 are found to be 7.2% and 10.8% respectively and rest is N_2 by volume. Determine the air-fuel ratio and percentage excess air considering air to have O_2 and N_2 in proportion of 23.2% and 76.8% respectively by mass.

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

a.	A boiler may have waste gases leaving the installation when artificial draught is used at 150°C. The natural draught chimney is of 60 m height. The hot gases within chimney are at temperature of 300°C and air requirement is 19 kg per kg of fuel burnt. The atmospheric air is at 17°C temperature and mean specific heat of hot gases is 1.0032 kJ/kg. K. The calorific value of fuel burnt is 32604 kJ/kg. Determine the following:

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	(i) the draught produced in mm of water (ii) the efficiency of chimney (iii) the extra heat carried away by flue gases per kg of fuel.
b.	A steam condenser has steam entering at 35°C and condensate being removed at 34°C. Condenser has two pumps one for extracting air and other for extraction of condensate. Air is removed at temperature of 33°C. The air leaks into condenser at the rate of 3 kg/hr. Consider the pressure inside condenser to remain uniform and neglect change in pressure due to air at steam inlet. Determine the volume of air handled by air pump in kg/hr and determine the volume to be handled if a combined air and condensate pump is being used.

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

a.	In a single stage impulse turbine, the isentropic enthalpy drop of 200 kJ/kg occurs in the nozzle having efficiency of 96% and nozzle angle of 15°. The blade velocity coefficient is 0.96 and ratio of blade speed to steam velocity is 0.5. The steam mass flow rate is 20 kg/s and velocity of steam entering is 50 m/s. Determine (a) the blade angles at inlet and outlet if the steam enters blades smoothly and leaves axially. (b) the blade efficiency (c) the power developed in kW (d) The axial thrust.
b.	Determine the mass flow rate of steam through a nozzle having isentropic flow through it. Steam enters nozzle at 10 bar, 500°C and leaves at 6 bar. Cross-section area at exit of nozzle is 20 cm^2. Velocity of steam entering nozzle may be considered negligible. Show the process on h-s diagram also.

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

a.	A gas turbine unit receives air at 1 bar, 300 K and compresses it adiabatically to 6.2 bar. The compressor efficiency is 88%. The fuel has a heating value of 44186 kJ/kg and the fuel-air ratio is 0.017 kg fuel/kg of air. The turbine internal efficiency is 90%. Calculate the work of turbine and compressor per kg of air compressed and thermal efficiency. For products of combustion cp = 1.147 kJ/kg K, $\gamma = 1.33$.
b.	What are the advantages and disadvantages of turbojet engines compared to other jet propulsion systems?