

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular/Backlog), November - December 2016

B. Tech Mechanical Engineering, Semester V

COURSE CODE: ME 509

COURSE TITLE: Applied Thermodynamics

Roll No.....

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.
4. Use compressibility charts and steam table.
5. Universal gas constant = $8.314 \text{ kJ/kg mole-K}$

Q.1 Objective type multiple choice questions

10

- i. Steam power plant operates:
 - a. Carnot cycle
 - b. Reverse Carnot cycle
 - c. Rankine cycle
 - d. None of the above
- ii. Steam power plant efficiency can be improved by:
 - a. Reheating
 - b. Increasing the boiler pressure
 - c. Reducing the condenser pressure
 - d. All of the above
- iii. Ideal working fluid for Thermal power plant is:
 - a. Low critical temperature and high working pressure
 - b. High critical temperature and high working pressure
 - c. Low critical temperature and low working pressure
 - d. None of the above
- iv. Reheat is done to :
 - a. Increase boiler pressure
 - b. Decrease the boiler pressure
 - c. all of the above
 - d. None of the above
- v. Preheating of water is done to:
 - a. Reduce heat input in boiler
 - b. Improve the efficiency
 - c. Recover the waste heat
 - d. All of the above
- vi. Stagnation properties represent :
 - a. A state of no change
 - b. A state of total energy
 - c. Any point of stationary fluid

- d. None of the above
- vii Critical properties of Isentropic flow are function of:
 - a. Heat capacity ratio
 - b. Volume flow rate
 - c. Mass flow rate
 - d. None of the above
- viii Flow of steam in a nozzle is:
 - a. Same as air flow in the same nozzle
 - b. Same as water flow in the nozzle
 - c. Different from air flow in the nozzle
 - d. All of the above
- ix In single stage Pelton turbine:
 - a. Single nozzle is used
 - b. Multiple nozzle is used
 - c. No nozzle is used
 - d. All of the above
- x Reaction turbine does not require compounding because :
 - a. It is already compounded
 - b. Single stage is sufficient
 - c. It does not matter
 - d. None of the above

Q.2 Describe various types of cooling tower with its components and figures 10

Q.3 Describe the following: 15

- a. Jet condensers
- b. Surface condenser
- c. Draught

Q.4 Consider a steam power plant operating on the ideal reheat Rankine cycle. The steam enters the high pressure turbine at 15 MPa and 600°C and is condensed in the condenser at a pressure of 10 kPa after expanding in two stages. If the moisture content of the steam at the exit of low pressure turbine is not to exceed 10.4 percent, determine (a) the pressure at which the steam should be reheated and (b) the thermal efficiency of the cycle. (c) Compare the results of efficiency of the power plant if the expansion is done in single stage. Assume that the steam is reheated to the inlet temperature of high pressure turbine. 35

OR

Q.4 a. Consider a steam power plant operating on ideal regenerative Rankine cycle with one open feed water heater. Steam enters the turbine at 15 MPa and 600°C and is condensed in the condenser at a pressure of 10 kPa. Some steam leaves the turbine at a pressure of 1.2 MPa and enters the open feed water heater. Determine the fraction of heat extracted from the turbine and thermal efficiency of cycle. 35

Q.5a. Derive the equation : 10

$$dA/A = - (dV/V)(1-M^2)$$

- b. Steam enters converging diverging nozzle at 2 MPa and 400°C with a negligible velocity and a mass flow rate of 2.5 kg/s and it exists at a pressure of 300 kPa. The flow is isentropic between the nozzle entrance and throat, and the overall nozzle efficiency is 93%. Determine: 25
- The throat and exit areas
 - The mach number at the throat and nozzle exit

OR

- Q.5 Steam 49 N/cm² and 160°C is supplied to single stage impulse turbine @ 30 kg/min from where it is exhausted to a condenser at a pressure of 1.96 N/cm². The blade speed is 300 m/s. The nozzle are inclined at 25° to the plane of the wheel and the outlet blade angle is 35°. 20

Neglect the friction and estimate:

- Theoretical power developed by the turbine
- The stage efficiency

Solve the problem using velocity diagram.

- b. The following readings were obtained during a boiler trial six hours duration. 15

Mean steam pressure = 12 bar

Mass of steam generated = 40000 kg

Mean dryness fraction = 0.85

Mean feed water temperature = 30°C

Coal used = 4000 kg

Calorific value of coal = 33400 kJ/kg

Calculate:

- Factor of equivalent evaporation
- Equivalent evaporation from and at 100°C
- Efficiency of Boiler