



VIT

Vellore Institute of Technology

# SCHOOL OF MECHANICAL ENGINEERING

Continuous Assessment Test - I - Fall Semester 2019-2020

Programme Name & Branch: B.Tech Mechanical, Energy and Automotive Engineering.

Course Name & Code: MEE 2030 Energy Systems Analysis and Design

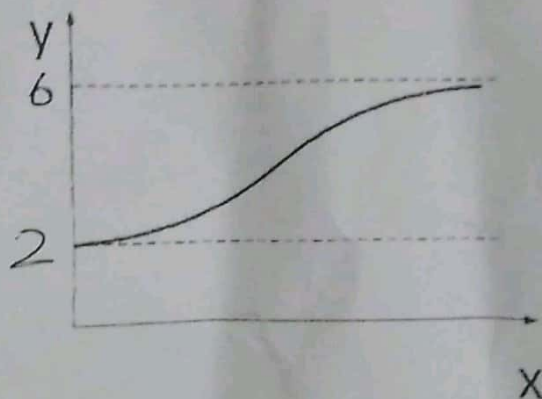
Class Number: 3909

Slot: F1 Exam Duration: 90 mins

Maximum Marks: 50

Answer all the questions

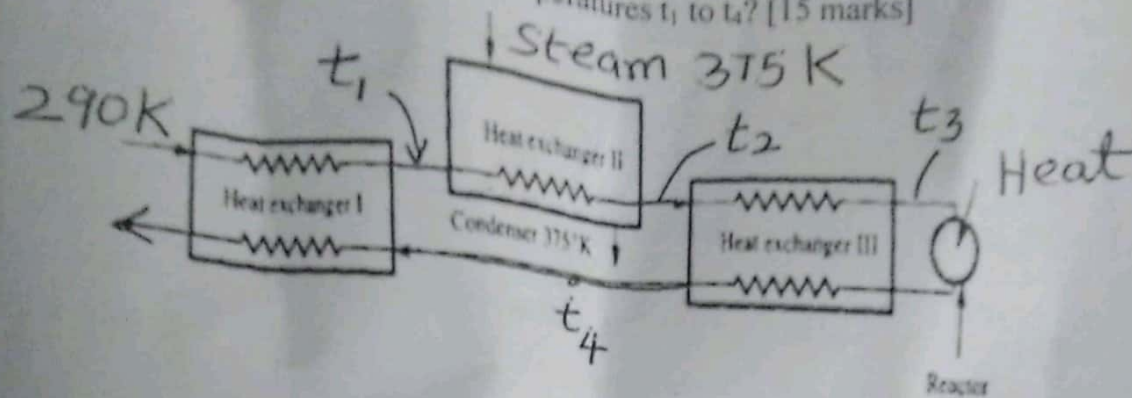
- 1
  - a) To provide for a plant expansion, additional steam and power are required. The concept creation phase can lead to a number of alternative solutions. Propose at least 5 alternative solutions for this problem. [5 marks]
  - b) Explain the difference between a workable system and an optimum system with an example. [5 marks]
- 2
  - a) Lagrange interpolation is to be used to represent the enthalpy of saturated air,  $h_s$ , kJ/kg, as a function of the temperature  $t^\circ\text{C}$ . The pairs of  $(h_s, t)$  values to be used as the basis are  $(9.47, 0)$ ,  $(29.34, 10)$ ,  $(57.53, 20)$ , and  $(99.96, 30)$ . Determine the values of  $c_1$  to  $c_4$  in the equation for  $h_s$ . [5 marks]
  - b) In a certain Gompertz equation which is  $y = ab^{c^x}$  and represented by the figure given below,  $c = 0.5$ ,  $y_0 = 2$  and the asymptote has a value of 6. Determine the values of  $a$  and  $b$ . [5 marks]



- 3 The chain of heat exchangers shown in the figure given below has the purpose of elevating the temperatures of a fluid to 390 K at which temperature the desired chemical reaction takes place. The fluid has a specific heat of 3.2 kJ/(kg . K) both before and after the reaction, and the flow rate is 1.5 kg/s. The entering temperature of the fluid to heat exchanger I is 290 K and the UA of this heat exchanger is 2.88

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kW/K. Steam is supplied to heat exchanger II at 375 K and condensate leaves at the same temperature. The UA values of heat exchangers II and III are 4.7 and 9.6 kW/K respectively. What are the values of temperatures  $t_1$  to  $t_4$ ? [15 marks]



4. A single-stage distillation tower receives 3 mol/s of butane-heptane. Liquid enters with a mole fraction of 0.5 butane, the still operates at 700 kPa, and the mixture leaves the partial vaporizer at a temperature of 110°C. What are the flow rates of liquid and vapour leaving the separator?

The saturation pressure-temperature relationships are

Butane:  $\ln(P) = 21.77 - 2795/T$

Heptane:  $\ln(P) = 22.16 - 3949/T$  where P is in pascals [15 marks]

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