

**DEPARTMENT OF CHEMICAL ENGINEERING  
INDIAN INSTITUTE OF TECHNOLOGY DELHI  
MAJOR**

**II Semester 2007-2008**

Date of Examination: 29/04/2008

Time: 2 hours

Full Marks: 40

Subject No.: CHL 702

Subject Name: Plant Design

Exam type: Open Book exam

**Instructions to students:**

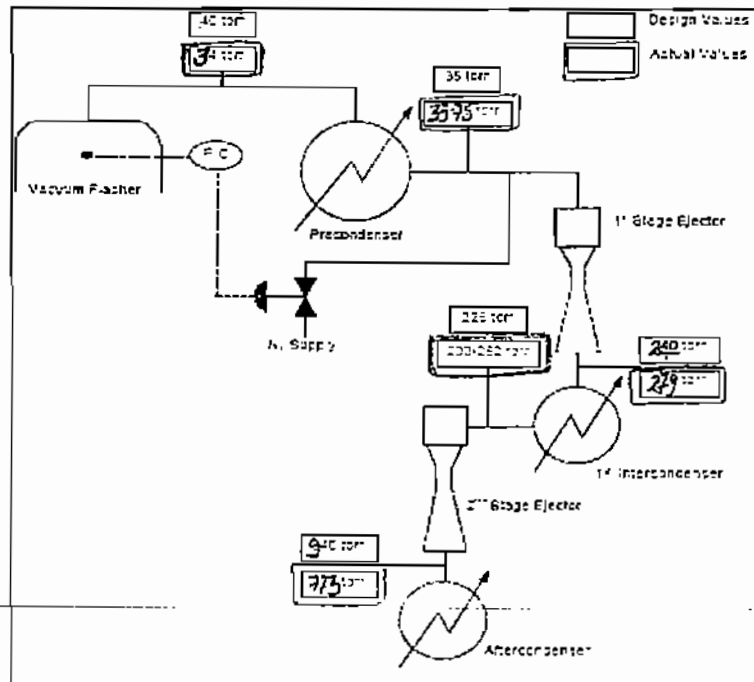
1. All questions are compulsory.
2. Make necessary assumptions if needed and state them clearly.

1. A tank car as shown in figure below is to be emptied of 10,000 gal of benzene at 80°F in 3 hr. The plant piping system is as indicated in the figure. Available to do the pumping is a centrifugal pump having the following characteristics:

Capacity, gal/min	Total Head, ft	Efficiency, %
0	110	0
20	106	29.2
40	90	40.0
60	63	45.0
80	41	47.0
100	22	48.3
120	12	46.5
140	7	40.0

- a) Is this pump satisfactory for the job? 2 marks
  - b) How long will it take to "empty" the tank car? 2 marks
  - c) How much work is necessary? 2 marks
2. A supply of gasoline at 20°C, viscosity of 0.667 centipoise and a specific gravity of 0.76 is pumped through a 150 mm standard horizontal pipe at a rate of 2 m<sup>3</sup>/min. At the end of 200m, this pipe branches into three lines consisting of 80, 50, and 25 mm standard pipes. If the pipes have respective lengths of 200, 100, and 50m and discharge at atmospheric pressure, what is the volume percent of total flow through each branch? 4 marks
3. A closed tank kept partially filled with oil (specific gravity = 0.9) has a pressure in the gas space above the oil of 10 psig. If the oil is discharging through a hose at 50 gal/min, estimate the pressure at the nozzle located 10ft lower than the oil surface and with a 1" ID discharge. Assume a total frictional loss in the line amounts to 1.0 ft-lbf/lb. 5 marks
4. A nylon production firm was operating vacuum flasher supported by a precondenser and two stage system as shown in figure below. Overload from the vacuum flasher consisted of 73600 kg/hr of mixed nitriles at a pressure of

approximately 35 torr. The precondenser produced adequate vacuum, but the two stage ejector system that extracted non-condensibles from the precondenser was performing in an unstable manner. Suction pressure of the first stage ejector was cycling between the design 35 torr and up to as high as 75-80 torr. Discuss possible reasons alongwith corrective measures for this poor ejector performance.



10 marks

5. In the enclosed P&ID, design a suitable PSV for E-2215 heat exchanger. Also, estimate the pressure drop across control valve PCV-309 in line 1"-VF-2032-CEX (above the vaporizer V-2127).

15 marks

