Question 1 (35 Marks)

A) Differentiate between open network and closed network manufacturing systems**. [6 marks]**

B) A production line is used to produce 25 units per week of a product. The product is assembled from one piece of part (a) and two pieces of part (b). The part (a) is produced through stations (A); station (B); and inspection station (C) with defect of 3% and reworked on station (B), while the part (b) is produced at station (D). After that, the two parts are assembled on station (E). The processing time of stations (A, B, C, D, E) are (40, 35, 10, 55, 15) minutes respectively. Then the product is tested on Inspection station (I) with processing time of 10 minutes and has defect rate of 6%. 50% of the defects are scraped and the reminders are returned to station (E).

i. Find **[5 marks each]**

(a) Determine the effective arrival rate at each station.
(b) Determine the number of machines at each station.
(c) Find the average work in process.
(d) Find the throughput time.

ii. Explain briefly a simulation model for the system **[9 marks]**

Queue length equation for single server

$$L=\frac{\rho}{1-\rho},\ \mathrm{L_q}=\frac{\lambda^2}{\mu(\mu-\lambda)},\ \rho=\frac{\lambda}{\mu},\ \mathrm{P_o}=1-\rho$$

Queue length equation for multi server

$$L=L_q+\frac{\lambda}{\mu},\ L_q=\frac{P_o(\lambda/\mu)^n\rho}{n!(1-\rho)^2},\ \rho=\frac{\lambda}{n\mu},\ P_o=\frac{1}{\sum_{i=0}^{i=n-1}(\lambda/\mu)^i+\frac{(\lambda/\mu)^n}{n!}\times\frac{1}{1-(\lambda/n\mu)}}$$

Throughput Time Equation

$$W=\frac{L}{\lambda},\ W_q=\frac{L_q}{\lambda}$$