NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

Bachelor of Engineering Honours Degree Industrial and Manufacturing Engineering

2nd Semester Main Examination

COURSE : MANUFACTURING SYSTEMS ENGINEERING

CODE : TIE 5215

DATE : MAY 2014

DURATION : 3 HOURS

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Answer **ALL** questions in **SECTION A** and any **THREE** in **SECTION B**.
2. All questions carry **20 marks** each.
3. This paper contains seven **(7)** questions.
4. There are four **(4)** printed pages.

SECTION A (Compulsory)

QUESTION 1

(a) A shop has one server. Customers arrive in the shop with a Poisson arrival distribution at a mean rate of 10 customers per hour. The server has an exponential service time distribution with mean service rate of 10 customers per hour. Determine the following system parameters:

i) Utilization [1]
ii) Average number of customers in the system [1]
iii) Average number of customers in the queue [1]
iv) Average waiting time [1]
v) The probability of waiting [2]

(b) Management wants to improve customer service and is therefore considering the following two scenarios:

Scenario 1: reduce service time by 50%
Scenario 2: increase number of servers to 2

Use the above listed system parameters to recommend the best approach to management. [14]

QUESTION 2

(a) Describe the two ways that are used in moving forward the simulation clock. [6]

(b) A small grocery shop has only one till. Customers arrive at the till at a uniform random distribution from 1 to 10 minutes apart. The service distributions and the random digits are shown in Table Q2a and Table Q2b respectively.

Table Q2a: Service times distributions

Service Time (min)	1	2	3	4	5	6
Probability	0.05	0.1	0.2	0.3	0.25	0.1

Table Q2b: Random Digits for Arrival and Service

Customer	1	2	3	4	5	6	7	8	9	10
Random Digits for Arrival	-	90	98	45	26	47	18	80	66	28
Random Digits for Service	91	25	51	92	89	81	67	61	74	43

i) Develop the simulation table and analysis for 10 customers. [12]
ii) What is the average waiting time for a customer? [2]

SECTION B

QUESTION 3

(a) Using appropriate diagrams and examples briefly describe four common configurations for queuing systems. [12]

(b) Determine the maximum length of a waiting line for specified probabilities of 95% and 98%, for a system in which the number of servers is 2, the arrival rate is 8 customers per hour, and the service rate is 5 customers per hour. [6]

(c) Explain the importance of knowing the maximum length of queue in infinite population models. [2]

QUESTION 4

(a) One operator services a bank of five machines. Machine running time and service time are both exponential. Machines run for an average of 90 minutes between service requirements, and service time averages 35 minutes. The operator receives $20 per hour in salary and fringe benefits, and machine down time costs $70 per hour per machine.

i) If each machine produces 60 pieces per hour while running, find the average hourly output of each machine, when waiting and service times are taken into account. [6]

ii) Determine the optimum number of operators. [6]

(b) Using examples distinguish between actual waiting time and perceived waiting time. [8]

QUESTION 5

(a) Distinguish between a finite population model and an infinite population model. [4]

(b) A job shop has three types of machines; one mill, two drill press, and one surface grinder. Orders arrive to the shop at a rate of 10 per day. 40% of these orders go to milling first and the other 60% start at drilling. 60% of the drilling jobs go next to milling, and the other 40% leave the system. 45% of the jobs being milled are sent for grinding, and the other 55% leave the shop. Operation times are exponentially distributed, averaging 10 jobs per day for milling, drilling, and grinding. Find the average number of jobs in the system. [16]

QUESTION 6

(a) Outline five managerial implications of waiting lines [10]

(b) A machine shop handles tool repairs in a large company. As each job arrives in the shop, it is assigned a priority based on urgency of need for that tool. Requests for repair can be described by Poisson distribution. Arrival rates are: $\lambda_1 = 2$ per hour, $\lambda_2 = 2$ per hour, and $\lambda_3 = 1$ per hour. The service rate is one tool per hour for each server, and there are six servers in the shop. Determine the following:

i) The average time a tool in each of the priority classes will wait for service. [5]

ii) The average time a tool spends in the system for each priority class. [5]

QUESTION 7

(a) Briefly describe any six basic process used in Arena simulation software. [12]
(b) Outline the steps involved in event - driven simulation. [8]

APPENDIX A – Table A: M/M/C Queueing Results		
	M/M/1	M/M/C
L	$L_s = \frac{\lambda}{\mu - \lambda}$	$L_q + \frac{\lambda}{\mu}$
L_q	$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$	$\frac{\rho(c\rho)^c p(o)}{c!(1-\rho)^2}$
W_q	$W_q = \frac{\lambda}{\mu(\mu - \lambda)}$	$\frac{(c\rho)^c p(o)}{c!c\mu(1-\rho)^2}$
W	$w_s = \frac{1}{\mu - \lambda}$	$W_q + \mu^{-1}$
P(0)	$P_o = 1 - \frac{\lambda}{\mu}$	$\left[\frac{(c\rho)^c}{c!(1-\rho)} + \sum_{n-o}^{c-1} \frac{(c\rho)^n}{n!}\right]^{-1}$
	$\rho = \frac{\lambda}{\mu}$	

END OF EXAM PAPER