NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

Master of Engineering in Manufacturing Systems and Operations Management

DESIGN, ANALYSIS AND CONTROL OF MANUFACTURING SYSTEMS

TIE 6111

First Semester Supplementary Examination Paper

July/ August 2015

This examination paper consists of 5 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: None

Examiner's Name: S Mhlanga

INSTRUCTIONS

1. Answer any **four (4)** questions, each carries 25 marks.
2. Use of calculators is permissible

MARK ALLOCATION

QUESTION	MARKS
1.	**25**
2.	**25**
3.	**25**
4.	**25**
5.	**25**
6.	**25**
7.	**25**
TOTAL	**100**

Question 1

a) Briefly discuss how the seven management and planning tools are used by a facilities design team. Use a bookshop as an example. [10]

b) Briefly explain with the aid of diagrams the requirements according to NSSA, Factories Act and City of Bulawayo By-laws, for **one** of the following facilities:
   i) Health facilities, [15]
   ii) Food service facilities, [15]
   iii) Restrooms for a factory with 10 Females and 50 males. [15]

Question 2

a) Briefly describe the steps taken in designing the unit load. [10]

b) Six machines are located on either side of a bidirectional conveyor system as shown in Figure Q2. For the flow information given in Table Q2, how can the machines be rearranged to minimize the time products spend on the conveyor? Assume the load transfer station for each machine is located in the midpoint of the machine edge facing the conveyor. Distances are given in metres. [15]

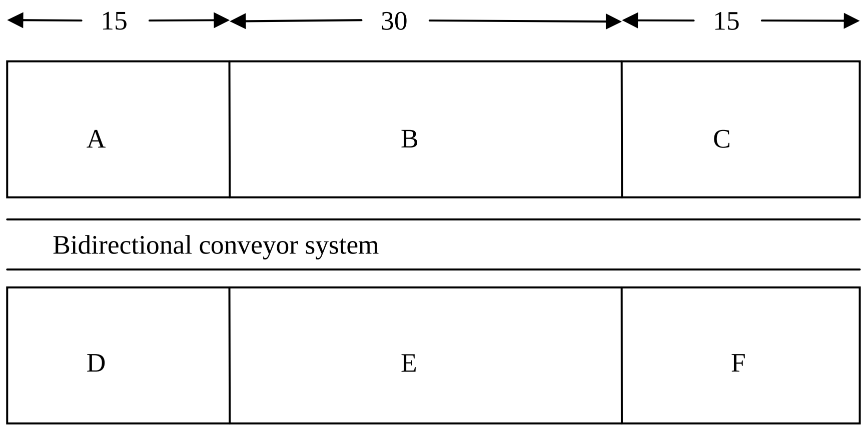

Figure Q2: Bidirectional Conveyor

Table Q2: Flow Information

	A	**B**	**C**	**D**	**E**	**F**
A	-	100	200	20	100	100
B		-	150	250	250	75
C			-	0	50	0
D				-	125	225
E					-	300
F						-

Question 3

Write a brief concise Matlab program that can be used to calculate the average Flowtime from an Earliest Due Date (EDD) and apply Simulated Annealing. [25]

Question 4

a) The activities of a new product must follow the precedence restrictions, task times (minutes) as given in Table Q4. Assuming the cycle time is 40 minutes.

   i) Find the lowerbound on the number of workstations required. [3]

   ii) Balance the line using Ranked Positional Weight technique. [12]

Table Q4: Precedence constraint and Task times Data

Task	**Time (in Minutes)**	**Immediate Predecessor Task (s)**
A	5	-
B	23	A
C	9	A
D	30	A
E	18	B
F	12	B,C
G	6	D, F
H	16	G
I	4	D
J	20	H, I
K	11	E, J

a) Briefly discuss the performance measurement you would consider if dealing with a mix-mode assembly. [10]

Question 5

a) Briefly explain what is a greedy knapsack problem using an example. [10]

b) A new flexible manufacturing cell is being designed and the objective is to select the set of part types to be produced in the cell. All parts are currently purchased. The cell will perform only boring and turning operations. Tools will be kept at the machines. A robot will be used for changing tools and loading and unloading of parts. Machine operations are time consuming compared with tool changes and part moves; hence the changing of tools and utilization of the robot should not be a problem. All units of a part must be acquired by the same alternative. The set of potential part types is shown in Table 5.1.

i) Suppose boring machines are inexpensive and we can buy as many as we need. The turning centre however is expensive and only 800 time units are available per period. Order parts based on their savings per unit of resource consumed and using a greedy heuristic, recommend a set of parts to manufacture in the cell. [15]

Table 5.1: Parts Data

Part	Demand/Period	Tuning (time/part)	Boring (time/part)	Purchase (cost/part)	Variable Machining (cost/part)
A	4	20	15	100	35
B	3	35	10	125	45
C	2	40	50	250	90
D	5	10	60	165	70
E	2	55	25	110	80
F	5	75	65	300	140
G	8	15	55	215	70

Question 6

a) A small printing shop has a self-service printer. Currently there is room for only 4 people to line up for the machine (including the person using the machine) when there are more than 4 people, then the additional people must line up outside the shop. The owners would like to avoid having people line up outside the shop as much as possible. For that reason they are thinking about adding a second self-service Printer. Self-service customers have been observed to arrive at a rate of 24 per hour and they use the machine 3 minutes on average. Assess the impact of adding another copier. Carefully state any assumptions or approximations you make. [10]

b) Visitors parking at Drive-in Bank are limited to five spaces only. Cars making use of this space arrive according to Poisson distribution at the rate of six cars per hour. Parking time is exponentially distributed with mean of 30 minutes. Visitors who cannot find an empty space immediately on arrival may temporarily wait inside the lot until a parked car leaves. That temporary space can hold only three cars. Others cars that cannot park or find a temporary waiting space must go elsewhere. Determine:

i) the probability of having n cars in the system, [2]
ii) the effective arrival rate for cars that actually use the parking lot, [2]
iii) the average number of cars in the lot, [2]
iv) the average time a car waits for a parking space inside the lot, [3]
v) the average number of occupied parking spaces, [3]
vi) the average utilization of the parking lot. [3]

Question 7

a) Nine components are to be manufactured on five machine types. The incidences are shown in Table 7.1. Machines are semi-automatic, and a worker can operate up to three machines. Determine a set of single-worker manufacturing cells. [15]

Table 7.1: Machine Utilizations

	Components								
Machine	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A	1			1		1			1
B		1	1		1	1			
C	1		1		1				1
D	1			1		1			
E			1	1			1	1	

b) Give five (5) major benefits associated with the implementation of Group Technology manufacturing philosophy. [10]

Table A.1 Queuing Formulae for Question 6

Table A.1: M/M/C Queuing 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(o)	$P_o = 1 - \frac{\lambda}{\mu}$	$\left[\frac{(c\rho)^c}{c!(1-\rho)} + \sum_{n-o}^{c-1} \frac{(c\rho)^n}{n!} \right]^{-1}$
	$\rho = \frac{\lambda}{\mu}$	

End of Examination