BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

FIRST SEMESTER 2022-2023
COMPREHENSIVE EXAMINATION
FUNDAMENTALS OF SYSTEMS ENGINEERING (CLOSE BOOK)

Course No: CE G515   Date: 19-12-2022 (MONDAY)
Duration: 3 hours   Max. Marks: 80 (40%)

ALL THE BEST

Important Instructions
1. Attempt all questions clearly and start new answer from a fresh page
2. You will also be asked to show your ID card during the examination
3. Make necessary assumptions

Q.1 It has been proposed to have green construction/development of a Dam. To ensure green construction/development, what all environmental impacts of the dams would you consider and what all different aspects of green construction technology can address those impacts? In particular, mention how presence of (landfill sites required to dump construction waste) near to the dam can have a negative impact. What would be your objectives and constraints to ensure green development/functioning of a dam in such a scenario? Design an optimization model dealing simultaneously with above mentioned objectives. Be precise and to the point in answering. Please do not write generic answer, be technical and scientific. **[5 M]**

Q.2 Drone manufacturing company specialized in developing customized drones for agricultural surveillance. The company focuses on developing drone wings, GPS system, landing gears, camera, remote, GCS, etc. The production line used to produce drone is a network system (Table below). Additional costs are associated with the activities if the company manager wants to reduce the overall time (or critical path). These costs are provided in the table below, as well as the maximum reduction in time per activity. All calculations must be performed taking duration in hours only. **[20 M]**

Activity	Description	Immediate predecessor	Duration (mins)
A	Receiving drone parts	-	30
B	Cutting the wings	A	60
C	Assembling parts	B	90
D	Transfer the machine	B	84
E	Fixing payload	D	72
F	Checking compatibility with GCS	B	48
G	Quality checks	F	60
H	Insert battery	C, E, G	24
I	Checking the product	H	84
J	Packaging of drone	I	30

Activity	Cost per hour of reducing duration of activity	Maximum possible reduction in duration of activity (min)
A	20	6
B	200	24
C	-	-
D	-	-
E	35	18
F	80	6
G	100	18
H	20	6
I	20	30
J	-	-

a. Draw the network diagram and determine the critical path using CPM. Show EST, EFT, LST, LFT in a table.
b. Calculate the total float and free float associated with each activity (provide your answer as a table).
c. Formulate a linear programming problem for minimizing the total time of the project.

d. In crashing analysis, time of an activity can be reduced at an additional cost as given in the table above. Develop a modified linear programming problem for the project needs to be completed in a time shorter than the current critical path. Also assume that the path time required is 6.3 hours.

Q.3 Draw a neat diagram representing reorder points, lead time, ordering cycle, demand rate in a classic EOQ model and in a step-wise manner, derive expressions for optimum inventory policy for static classic EOQ model. Use standard notations. Mention necessary assumptions. **[3 M]**

A factory uses an external laundry service to provide clean towels used for cleaning the machinery. The factory generates 600 soiled towels a day. The laundry service picks up the soiled towels and replaces them with clean ones at regular intervals. There is a fixed charge of $81 per pickup and delivery service, in addition to the variable cost of $0.60 per towel. It costs the factory $ 0.02 a day to store a soiled towel and $ 0.01 per day to store a clean one. How often should the company use the pick-up and delivery service? Please suggest an optimal policy. **[7 M]**

Q.4 Sugar mill in Muzaffarnagar produces a certain product, which is sold at a uniform rate of ₹ 25 each. The variable cost of producing this product works out to be ₹ 15 per unit and the fixed cost associated with this product and process for manufacturing this product is ₹ 90,000. Answer the following: **[10 M]**
a. How many units of the product must be produced and sold so that the company breaks even?
b. How much rupee value of sales to be made at the break-even level?
c. If the company has a target to achieve a profit of ₹ 20,000, then how many units should be sold?
d. If the company has to maintain a safety margin of 20%, then how much minimum quantity should it manufacture?

Q.5 (i) The following information is available for an activity in the PERT network: **[5 +10 = 15 M]**
Expected time = 4 days; Most likely time = 4 days; Variance = (1/9) days^2. Find the optimistic and pessimistic time

(ii) The data for a PERT network is given below.

Activity nodes	1→2	1→3	1→4	2→3	2→5	3→4	3→6	4→6	5→6
Optimistic time (days)	2	6	6	2	12	15	3	9	4
Most likely time (days)	4	6	12	5	14	24	6	15	10
Pessimistic time (days)	6	6	24	8	28	45	9	27	16

a. Draw network diagram and find out critical path
b. Estimate expected duration of the project and the corresponding variance
c. What is the probability that the project duration will exceed 60 days?
d. What is the chance of completing the project between 45 and 54 days?
e. What is the probability of completing the project within 30 days?

Q.6 The below tables gives the schedule and manpower requirement for a project. **[10 M]**
a. Draw the load histogram.
b. Perform resource smoothing and clearly represent in the form of a load histogram.
c. What is the peak and lowest requirement of the resource and on which days(s) it occurs?

Activity	A	B	C	D	E	F	G	H	I
Predecessor	-	-	A	A	B	D, E	C	F	G, H
Duration (days)	3	4	2	3	6	3	5	6	7
Manpower required	60	84	22	36	72	18	35	42	56

Q.7. A product experiences demand as shown in the Table below for the past 20 time periods. Find the forecast for the 21st time period using double exponential smoothing. The value of α is 0.6 and γ is 0.7. Show all values in the table. Plot a graph showing the forecast and the actual demand. The initial forecast is 56 and trend forecast is zero. **[10 M]**

Week	1	2	3	4	5	6	7	8	9	10
Demand	56	61	66	74	81	85	78	89	92	96
Week	11	12	13	14	15	16	17	18	19	20
Demand	100	102	99	110	113	119	125	128	134	137

THANK YOU