Course No: CE G515	**Date: 31-10-2022 (Mon)**
Duration: 90 min (4:00 – 5:30 PM)	**Max. Marks: 30**

Q.1. A Civil engineer manufactures two different types of cement namely A and B. To manufacture cement, the engineer needs three types of chemicals, X, Y and Z, whose minimum requirements are 10, 12 and 12 units respectively. Cement A contains 5, 2 and 1 unit of X, Y and Z per bag and B contains 1, 2, and 4 units of X, Y, and Z per bag respectively. Production per bag of A and B costs ₹ 3 and ₹ 2 respectively to the engineer. How many bags of each cement be produced to minimize the cost and obtain the requirements? Use two-phase method. [5 M]

Q.2. A solar power plant employs fours specialist scientists in the solar panel repairing area. Not all the solar panels arriving for the service require repair and only those requiring some tuning or de-carbonizing are sent to the repair department. The scientists can repair one solar panel at an average time of two hours. The panels are registered at a single point and then directed to any of the four scientists, in case there is an repair related problem. The panels requiring repair services arrive at an average rate of 1.5 panels per hour. Determine the following:
[10 M]

a. The utilization factor
b. Probability that the system shall be idle
c. Probability that there will be four panels requiring repair
d. Probability that there will be eight panels requiring repair services
e. Expected number of panels waiting in the queue for repairs
f. Expected number of panels in the queue and receiving service in the repair department
g. Average waiting time in the queue in the repair area
h. Average time being spent by the panel in waiting for repair service and in getting repaired

Q.3. Covid-19 vaccines have been delivered continuously to a hospital and the vaccine is adminsitered to the people by the hospital doctors. The interarrival (vaccine delivery) and service times (vaccine administration) are studied over the past few years for a single channel queuing system revealed the patterns as shown in the Table.

Inter-arrival time		Service time	
Minutes	Probability	Minutes	Probability
2	0.19	1	0.15
4	0.22	3	0.28
6	0.32	5	0.30
8	0.17	7	0.17
10	0.10	9	0.10

Using the following random numbers, simulate the queue behavior for a period of 60 minutes. Random numbers for inter-arrival time: 20, 32, 59, 81, 27, 45, 27, 52, 77, 46, 85, 83, 34, 42, 43. Random numbers for service time: 10, 27, 74, 96, 48, 07, 65, 78, 92, 49, 12, 63, 10, 06, 97. Using the simulation table (a) estimate the probability of server being idle, and (b) the mean time spent by the customer waiting for the service.   [10 M]

Q.4. Please explain how Queuing system analysis is different from Optimization and Simulation models. [5 M]

In a machine repairing company, workers must get their tools from the tool centre, which is staffed by a single person. The average number of workers asking for tools are 5 per hour, and the average time taken to handle one request for tools is 10 minutes. The server is paid 5 $ per hour and each worker is paid 8 $ per hour. Now, the server complains that he/she is overloaded and that many workers waste their time queueing for tools. Thus, the manager wonders if it is cost effective to employ an extra server at the tool centre. Assuming that the inter-arrival time of workers and the processing time of the servers are exponentially distributed:

   a) Write down a Kendall notation for the existing system. Use the number of workers waiting for tools as the state.
   b) From the model, determine the average number of workers waiting for tools at the tool centre (including the worker being served).
   c) Calculate the average cost per hour of providing tools. This will include the cost of time lost by the workers, and the cost of employing the tool distributor.
   d) Supposing that there are now two tool centres (each with a tool distributor), see if employing a second distributor is justified?