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**Anna University, Chennai**  
**B.E. 6<sup>th</sup> Semester Industrial Engineering**  
**IE 9032 Systems Engineering**  
**End-Semester (Arrears) Examination, November 2011**

**Max Time: 3 hours**

**Max Marks: 100**

**(Part – A: 10 x 2 = 20 marks)**

1. What is the conceptual relation among the three life-cycles of systems engineering?
2. What is the functional definition of Systems Engineering? Why systems engineering is described as management technology?
3. Define the terms: quadratic ratio, impact factor, and shilling fraction.
4. Define the functions  $f(t)$ ,  $F(t)$ ,  $R(t)$ , and  $H(t)$  w.r.t. to useful life period of a product.
5. Give examples of directed, non-directed, signed, and weighted graphs.
6. What is the importance of little's law in Queuing theory?
7. What is the relation between stock and flow variables in system dynamics?
8. Classify multi-criteria decision problems and the associated techniques
9. Differentiate between prescriptive, descriptive, and normative decision making
10. Define social preference relation used for deriving group preference ordering?

**(Part - B: 5 x 16 = 80 marks)**

**11 (i)** Identify the relevant elements of issue formulation (problem definition, value system design, and system synthesis) taking an example of complex problem for Systems Engineering study.

(ii) Present the dynamics of stocks and flows w. r. t. modeling of epidemics considering the susceptible, infectious, and recovered population as stocks. Present the feed back loops.

**12 (a)** Conduct Cross-Impact analysis for the following two events:

Event-1: Year 2007, Passing law banning outsourcing of IT jobs

Event-2: Year 2010, Decrease in unemployment rate

Experts estimates of  $P(1) = 0.4$ ,  $P(2) = 0.2$ ,  $A_{12} = -0.5$ ,  $A_{21} = 0.3$

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Present causal loop diagram, develop event tree for the two event model, and compute probabilities of possible future events. Verify impacted probabilities with Bayes' rule.

(OR)

12 (b) Present general formulation of goal programming problem.

A company supplies a single product from two warehouses to three of its customers. The supplies at the warehouses are 120 and 70 units, respectively. The customer demands are 70, 80, and 100 units respectively. The net profit associated with shipping one unit from warehouse  $i$  to customer  $j$  is given below:

	Customer		
	1	2	3
Warehouse-1	7	9	8
Warehouse-2	3	4	6

The company has set the following goals for shipping:

1. Meet the demand of customer-3
2. Meet at least 60% of the demand of customers 1 and 2.
3. Maximize the total profit from goods shipped
4. Balance the percentage of demands satisfied between customers 1 and 2

Formulate the above problem as a Goal Program

13 (a) A sample survey on brand switching pattern of 1000 consumers of a product has revealed the following data:

Number of consumers using a specific brand of the Product as on 1st January

Brand - A	Brand - B	Brand - C
200	500	300

The following table indicates the number of consumers switched over among the three brands during the month of January

From	To (A)	To (B)	To ©
Brand-A	-	35	25
Brand-B	20	-	20
Brand-C	20	15	-

Assuming that the underlying brand switching process is a Markov process, derive the Transition Probability Matrix. Present the associated state Transition diagram. State the

Markov assumptions. For steady state analysis, write down the steady state equations. Derive the market shares of the three brands in the long run.

(OR)

**13 (b)** Evaluate alternative project proposals where each project requires an initial investment of Rs. 50,000. Project-A will return Rs.100,000 in a period of two years, Project-B will return Rs. 150,000 in a period of three years, and Project-C will return Rs.200,000 in 4 years. Assuming a discount rate of 10% per year, compare the projects based on Net Present Worth and ROI criteria. How do you use the IRR criterion to evaluate the three alternatives?

**14 (a)** Consider a two station production system in which fresh parts arrive at station-1 at a Poisson rate of 8 per hour; production time at stage-1 is exponentially distributed with a mean of 4 min including inspection. If a unit is defective and can be reworked, it is placed at the end of the queue and is reprocessed at station- 1. It is found that 15 % of the items inspected are reworked, 5 % are rejected and the remaining goes to station-2. Processing time at station-2 is exponentially distributed with a mean of 6 min. All items processed by station-2 leave the system. Apply the principles of Jackson's network to compute mean number in the system and MLT.

(OR)

**14 (b)** In a machine shop, each machine operates for an average of 8,000 hours between chance failures (MTBF). What is the chance failure rate? A machine has been in operation for 12,000 hours without failure. Determine the reliability of the machine for the next 3,000 hours.

If the mean time for wear out failures on these machines is 20,000 hours with a standard deviation of 2,000 hours, how do you estimate the total reliability?

**15 (a)** What are the steps followed in conducting AHP analysis to rank decision alternatives?

The results of AHP from the responses of six managers in an organization are presented in the following preference orderings of three alternatives, a, b, and c:

Manager-1 = (a, b, c) = Manager-5

Manager-2 = (c, b, a) = Manager-4

Manager-3 = (b, a, c) = manager-6

Derive social preference relation. Obtain the group level of agreement and associated ordering of alternatives.

(OR)

**15 (b)** An individual is in the process of buying a car and has narrowed the choices to three models: M1, M2, and M3. The deciding factors include purchase price (PP), maintenance cost (MC), cost of city driving (CD), and cost of rural driving (RD). The following table provides the relevant data for a 3-year operation:

Car model	PP(\$)	MC(\$)	CD(\$)	RD(\$)
M1	6000	1800	4500	1500
M2	8000	1200	2250	750
M3	10,000	600	1125	600

Use the cost data to develop the comparison matrices. Determine the choice model using **AHP**.