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(22)

**Anna University Chennai**
**B.E. 6th Semester, Industrial Engineering**
**IE 9032 Systems Engineering**
**End-Semester Examination, May 2012**

**Max Time: 3 hours** **Max Marks: 100**

**(Part – A: 10 x 2 = 20 marks)**

1. Present definitions of Systems Engineering.
2. Explain first order negative feedback system with a suitable example.
3. What are the conventions followed in the development of influence diagrams?
4. What is the relation among the three life cycles of systems engineering?
5. How morphological box approach is different from delphi technique?
6. Define the Markov states: recurrent, transient, and absorbing.
7. How utility functions differentiate risk taker and risk averse person?
8. What are the products of Value system design and System synthesis steps?
9. How causal loops are different from stock and flow variables in system dynamics?
10. Describe Borda voting system, with an example.

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

**11.** How expected value theory differs from utility theory?

Two different routes can be used to travel between two cities. Route-A normally takes 60 minutes, while Route-B normally takes 45 minutes. If traffic problems are encountered on Route-A, the travel time increases to 70 minutes; traffic problems on Route-B increase travel time to 90 minutes. The probability of delay is 0.2 for Route-A and 0.3 for Route-B.

(i) Using expected value approach, what is the recommended route?

(ii) If utilities are to be assigned to the travel times, what is the appropriate lottery? Note that the smaller times should reflect higher utilities.

(iii) Using the lottery of part (ii), assume the decision maker expresses indifference probabilities of
p = 0.8 for 60 minutes
p = 0.6 for 70 minutes
What route should this decision maker select?
Whether the decision maker is risk avoider or risk taker?

**12 (a)** Identify the relevant elements of issue formulation (problem definition, value system design, and system synthesis) for the problem of global warming for Systems Engineering study.

**(OR)**

**12 (b)** 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 and associated differential/ integral equations of the model.

**13 (a)** The manager of a company must decide whether to manufacture a component part at its plant or purchase the component part from a supplier. The resulting profit is dependent upon the demand for the product. The following payoff table shows the expected profit (in $1000s).

| | State of nature | | |
|---|---|---|---|
| | Low demand | medium demand | high demand |
| Decision Alternative | s1 | s2 | s3 |
| Manufacture (d1) | -20 | 40 | 100 |
| Purchase (d2) | 10 | 45 | 70 |

The state of nature probabilities are P(s1) = 0.35, P(s2) = 0.35, P(s3) = 0.30

(i) Use a decision tree to recommend a decision

(ii) Use EVPI to determine whether the manager should attempt to obtain a better estimate of demand.

(iii) A test market study of the potential demand for the product is expected to report either favorable (F) or Unfavorable (U) condition. The relevant conditional probabilities are as follows:

P(F | s1) = 0.20, P(U | s1) = 0.80

P(F | s2) = 0.30, P(U | s2) = 0.70

P(F | s3) = 0.80, P(U | s3) = 0.20

(iv) What is the probability that the market research report will be favorable?

(v) What is the Manager's optimal decision strategy?

(vi) What is the expected value of the market research information?

(vii) What is the efficiency of the information?

**(OR)**

**13 (b)** Present general formulation of pre-emptive goal programming model and explain the terms associated with it.

A committee in charge of promoting tennis tournament is trying to determine how best to advertise the event during the two weeks prior to the tournament. The committee obtained the following information about the three advertising media they are considering.

| Category | Audience reached per advertisement | Cost per advertisement ($) | Max number of advertisements |
|---|---|---|---|
| TV | 200,000 | 2500 | 10 |
| Radio | 50,000 | 400 | 15 |
| News Paper | 100,000 | 500 | 20 |

The last column in the table shows the maximum number of advertisements that can be run during the next two weeks; these values should be treated as constraints. The committee has established the following goals for the campaign.

Priority level-1 goal:
Goal-1: Reach at least 4 million people

Priority level-2 goal:
Gola-2: The number of TV advertisements should be at least 30% of the total number of advertisements.

Priority level-3 goal:
Goal-3: The number of radio advertisements should not exceed 20% of the total number of advertisements.

Priority level-4 goal:
Goal-4: Limit the total amount spent for advertising to $ 20,000.

**Formulate** a goal programming model for this problem. Assume that priority level-1 goal is twice as important as priority level-2 goal, priority level-2, 3 and 4 goals are equally important.

**14 (a)** Define the terms: Stochastic networks, Transition probability matrix, and Markov property.
A production machine is inspected at the end of each day's effort. It can be found in one of the following four states. :

1. As good as new, no faults
2. Operable, but with minor faults
3. Operable, but with major faults
4. Inoperable

Data are obtained relative to the transition from one state to the other. These results are described in the following Transition Probability matrix.

To State

| From State | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 0 | 0.7 | 0.2 | 0.1 |
| 2 | 0 | 0.8 | 0.1 | 0.1 |
| 3 | 0 | 0 | 0.4 | 0.6 |
| 4 | 0 | 0 | 0 | 1 |

Evaluate the following two alternative policies:

I. Replace when the machine becomes inoperable (when in state 4, bring it to state 1)
II: Renovate when it enters in state 3, and replace when in state 4 (for renovation bring it from state 3 to state 2)

**(OR)**

**14 (b)** Consider a three station production system in which fresh parts arrive at station-1 at a Poisson rate of 10 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 20% of the items inspected are reworked, and the remaining goes to station-2. Processing time at station-2 is exponentially distributed with a mean of 5 min. Items processed by station-2 are subjected to inspection. It is found that 5% of the items inspected are rejected and the rest go for processing at station-3. Processing at station-3 is exponentially distributed with a mean of 6 min. All the items processed by station-3 leave the system. Determine WIP and MLT. (Apply product form solution of open Q-net).

**15 (a)** Describe four common voting systems.

Consider a group of eight decision makers and their preference ordering on a set of four alternatives a, b, c, and d as shown below:
P1 = (a, b, c, d)
P2 = P5 = (d, c, b, a)
P3 = P7 = (b, a, c, d)
P4 = P8 = (a, d, b, c)
P6 = (d, a, b, c)
Derive social preference relation. Obtain the group level of agreement and associated ordering of alternatives

**(OR)**

**15 (b)** Write briefly on:

(i) Cross-impact analysis
(ii) Tools for functional analysis
(iii) Decision assessment types
(iv) Group dialogue techniques