

Total No. of Questions : 8]

SEAT No. :

PE2403

[Total No. of Pages : 4

[6584]-343

B.E. (Robotics & Automation Engg.)

ROBOT SYSTEM RELIABILITY AND SAFETY

(2019 Pattern) (Semester - VII) (411502)

Time : 2½ Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) Solve Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8.
- 2) Figure to the right indicates full marks.
- 3) Neat Diagram must be drawn wherever necessary.
- 4) Assume Suitable data if necessary.
- 5) Use of Logarithmic Table, Slide rule is Electronic pocket calculator is allowed.

Q1) a) A computer used for controlling robot consists of three sub-system having consecutive failure rates $\lambda_1 = 0.015$, $\lambda_2 = 0.018$, $\lambda_3 = 0.023$ failures per month. Select the requirements of reliability through 36 months in service to achieve total reliability as 0.98 using ARINC Method of Reliability Allocation. Also, check if the total reliability goal of computer is achieved. [9]

b) Explain the concept of redundancy. Explain any two methods of redundancy. Also, find reliabilities of these methods. [8]

OR

Q2) a) Apply the AGREE allocation method to a robotic system containing the following components : [9]

Component = C. Parts count = PC Importance index = IND Operating time hr/yr = OT

C: Control System. PC : 153 IND : 0.95 OT : 2000

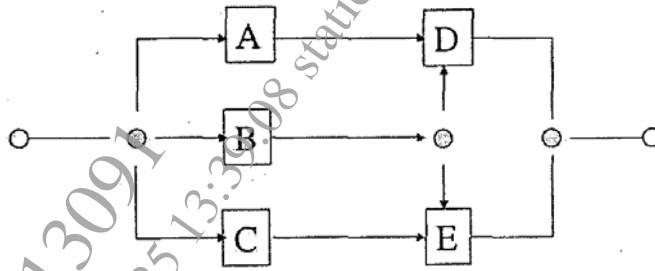
C: Motor drive. PC : 28 IND : 0.90 OT : 1000

C: Actuation System PC : 34 IND : 1.00 OT : 2000

The warranty program requires a reliability of 0.99 over the first year of use.

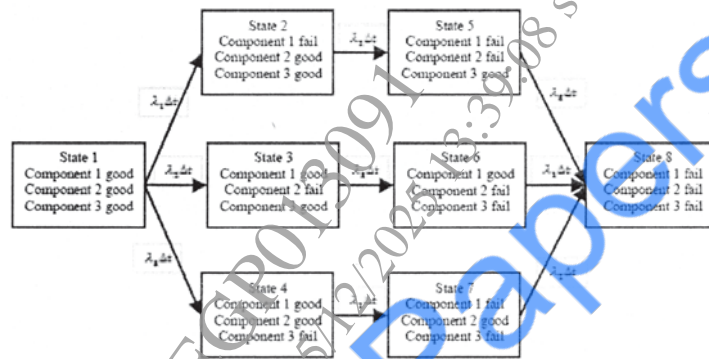
P.T.O.

- b) Consider below System. Use inspection technique and find an equation for the reliability of the system if all chunks are identical and independent. [8]



Find the reliability of the following system if the probability of success of each component is 0.8.

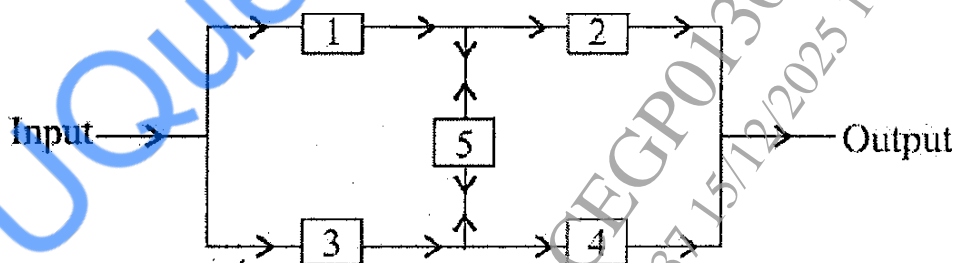
- Q3) a) Find an expression of reliability using Markov Analysis Method for the 3-unit system having following transition state diagram: [9]



- b) Find the mean time between failure for the above problem (Q.3 A) using Markov Analysis. [9]

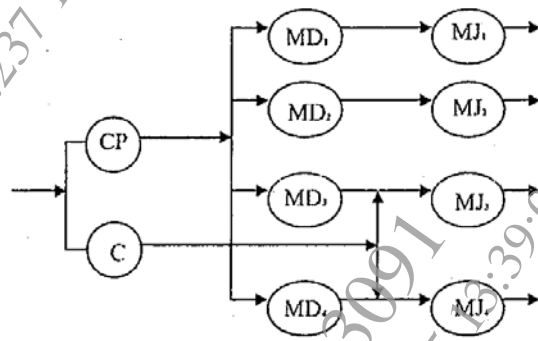
OR

- Q4) a) Using the decomposition method or conditional probability approach, evaluate the reliability of the system having reliability block diagram shown in figure below: [9]



Assume that each component has a reliability of 0.95 for a mission of 1000 hours. Also assume that the components are independent.

- b) A robotic motor system consists of a motor drive and motor joint assembly as subsystems controlling motor system. Both the subsystem must fail in order for the failure of the system. The robot control system will fail if the control panel (CP) (which includes the motor drives) or all four-motor joints fail. The motor subsystem will fail if the motor drive fails ($MD_1, MD_2, MD_3,$ and MD_4) or the Motor Joint assembly fails (events MJ_1, MJ_2, MJ_3, MJ_4). The robotic motor system will fail if the cable system fails (event C) or both arm and wrist motor joint assemblies fail (events MJ_3, MJ_4). Find the reliability relation using decomposition method, if the reliability block diagram of the system is as shown below: [9]



The reliability of the cable is 0.9 and the control panel is 0.92. Find the reliability of the robotic motor system if each subsystem of motor drives has the reliability of 0.95 and of motor joints as 0.85.

- Q5) a) If sampling was conducted for a worker working with for air contaminant containing heptane for two cases as below: [9]

Case-1 The worker worked for seven hours and the concentration for that seven hour was 500 parts per million (ppm) for a shift of 8 hours.

Case-2 The worker worked for one workspace for 2 hours with 100 ppm exposure and in another workspace for 3 hours with 200 ppm for a shift of 8 hours.

Find time weighted average for both the cases according to OSHA specification. Also check is this exposure is within the safe range if safe range of time weighted average for heptane is 400 ppm as per OSHA.

- b) Explain RULA and REBA to evaluate musculoskeletal disorder. [9]

OR

- Q6)** a) Explain in detail about ISO45001 : 2018. [9]
b) Explain in detail about Electrical Hazards. [9]

- Q7)** a) What are Unsafe Conditions and Unsafe Act? Explain with relevant examples and case study. [8]
b) Explain various types of Toxicity. [9]

OR

- Q8)** a) What are various methods to avoid, control and measure hazards? Explain with relevant case study. [8]
b) What are Material Safety Data Sheet (MSDS) according to 29 CFR 1910.1200(g) regulation (revised 2012) of Occupational Safety and Health Administration (OSHA)? [9]

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