Reg. No. | | | | | | | | | | |

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.)

END SEMESTER DEGREE EXAMINATIONS, DECEMBER - 2020

SUBJECT: RELIABILITY AND SAFETY ENGINEERING [ICE 4029]

28-12-2020

TIME: 3 HOURS MAX. MARKS: 50

Instructions to candidates :*Answer ALL questions and missing data may be suitably assumed.*

1A. Derive the expression for failure rate of a continuous random variable.

1B. To ensure safe shutdown of nuclear power plants (NPPs) during normal or accidental conditions a primary shut down system (SDS), and a redundancy secondary shut down system (SDS) are present. The failure probability of the primary SDS is 0.01 and of the secondary SDS is 0.035. Calculate the reliability of the overall SDS of an NPP.

1C. Define the following:
i. Cut set
ii. Observed score
iii. Reliability coefficient
iv. RISK

(4+4+2)

2A Differentiate reliability and validity with an appropriate example for each.

2B Prove that component redundancy of a product is better than the system redundancy of a product.

2C Evaluate the MTTF for the system depicted in Figure Q2C. Components are used during the phase with an approximately constant failure rate of the bath-tub curve and $\lambda=\lambda_1=\lambda_2=\lambda_3$.

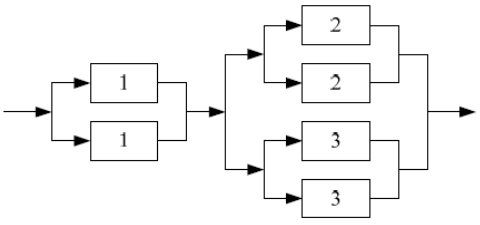

Fig Q 2C. Reliability block diagram

(2+3+5)

3A Describe the procedure followed to carry out the fault tree analysis.

3B Derive the expression for mean and variance of a weibull distribution.

3C Determine the reliability of an airplane with four propellers, two of these propellers (A and B) are on the left wing and the others (C and D) are on the right wing, such as depicted in Figure Q3C. The airplane will fly if at least one propeller on each wing functions. Unreliability of each propeller are FA=0.8, FB=0.7, FC=0.6, FD=0.9. Draw the reliability block diagram for the airplane.

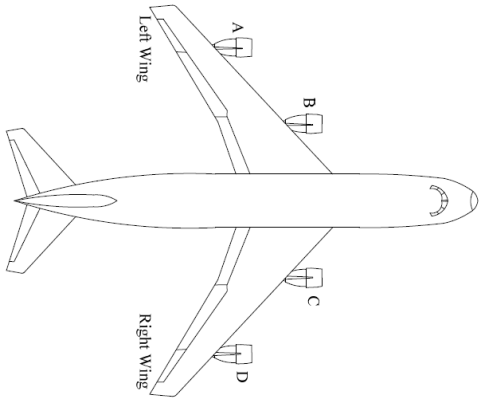

Figure Q3C. Aeroplane with four propellers

(5+3+2)

4A Demonstrate test - retest method.

4B Using Maximum Likelihood Estimator, estimate the failure rate of exponential distribution whose data is given in Table 4B.

Table 4B.

TBF (hours)	2600	3200	4700	7400	8000	9800
$R(t_i)$	1	0.5	0.3	0.1	0.066	0.033

4C Illustrate Rasmussen's human behaviours and errors.

(3+3+4)

5A With a neat flow chart explain Probabilistic Safety Assessment (PSA) procedure.

5B Describe the focused improvement pillar of TPM.

5C With a neat flow chart, explain the conceptual framework of design for safety and liability.

(4+2+4)

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