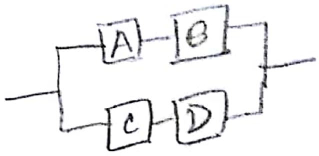
Task-2.3

(a)



$R_s(t) = \prod_{i=1}^{N} R_i(t)$

Here,
$R_A = R_B = R$
$R_C = R_D = R$

So, $R_{AB} = R_A \cdot R_B$

again $R_{CD} = R_C \cdot R_D$

$R_p(t) = 1 - \prod_{i=1}^{N} (1 - R_i(t))$

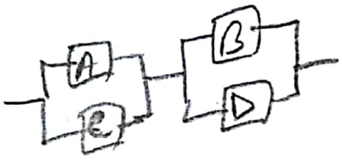
So, $R_{sys} = 1 - [(1 - R_{AB})(1 - R_{CD})]$

$R_{sys} = 1 - (1 - R_A \cdot R_B)(1 - R_C \cdot R_D) = 1 - (1 - R^2)(1 - R^2)$

$= 1 - 1 - R^2 - R^2 + R^4$

$R_{sys} = R^4 - 2R^2 = R^2(R^2 - 2)$

(b)



$R_p(t) = 1 - \prod_{i=1}^{N} (1 - R_i(t))$

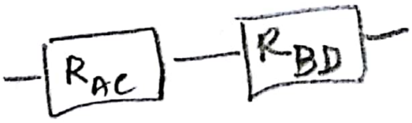
Here
$R_A = R_C = R$
$R_B = R_D = R$

$R_{P_{AC}} = 1 - (1 - R_A)(1 - R_C) = 1 - (1 - R)(1 - R)$

$= 1 - 1 - 2R + R^2$

$\boxed{R_{P_{AC}} = R(R - 2)}$ ...... ①

Similarly, $\boxed{R_{P_{BD}} = R(R - 2)}$ ...... ②

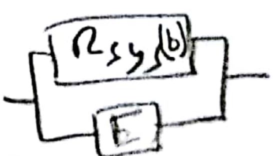


$R_{sys} = R_{P_{AC}} R_{P_{BD}}$

$= R(R - 2) \cdot R(R - 2)$

$\boxed{R_{sys} = R^2(R^2 - 4R + 4)}$

(c) From (b) => we can design system =>



$R_{sys}(c) = 1 - [(1 - R_{sys}(b))(1 - R_E)]$

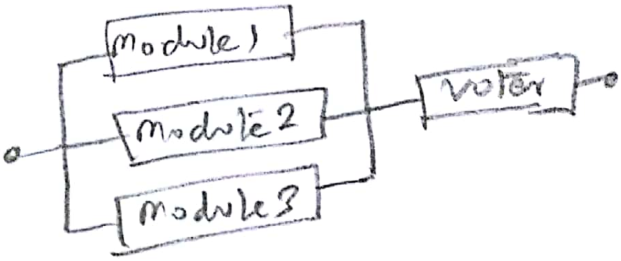
$= 1 - [(1 - R^4 + 4R^3 - 4R^2)(1 - R)]$

$= 1 - [1 - R^4 + 4R^3 - 4R^2 - R + R^5 - 4R^4 + 4R^3]$

$\boxed{R_{sys}(c) = R(1 - R^4 + 5R^3 - 8R^2 + 4R)}$

Task 2.5.

1. Formula for the Reliability of TMR:-



cases:
1. All 3 modules are working
2. Any 2 modules are working & 1 module is failed
3. The voter is single-point-of-failure.

Assumtion: The voter has a reliability of 1.0.

The TMR reliability is given by:

$$R_{TMR}(t) = R_1(t) R_2(t) R_3(t) + R_1(t) \cdot R_2(t) (1 - R_3(t)) + R_2(t) \cdot R_3(t) (1 - R_2(t)) + R_1(t) R_3(t) (1 - R_2(t))$$

Now, if $R_1(t) = R_2(t) = R_3(t) = R(t)$

$$R_{TMR}(t) = R^3(t) + 3R^2(t) - 3R^3(t) = 3R^2(t) - 2R^3(t).$$

2. Graph is ploted in Matlab.

TMR system become less reliable than the original system; consisting of a single component,

=> system exhausted redundancy, more hardware can possibley fail.

$$\boxed{R_{TMR}(t) \le 0.50.}$$

3) (a) Upper bound for the failure Rate.

$R_{TMR}(t) \geq R(t)$ ...... (1)

$R_v(t) \cdot R_{2:3}(t) \geq R(t)$

$R_v(t) \cdot [3R^2(t) - 2R^3(t)] \geq R(t)$.

$R_v(t) \cdot [3('90)^2 - 2('90)^3] \geq '90$

$R_v(t) \cdot ('972) \geq 0'90$

$R_v(t) \geq \frac{0'90}{0'972} \geq '093$

$e^{-\lambda_v(t)} \geq '93$

$-\lambda_v(t) \geq \log_e('93) \geq -0'0726$.

$\lambda_v (0'0527) \leq 0'0726$.

$\lambda_v \leq \frac{0'0726}{0'0527}$.

$\lambda_v \leq 1'3776$.

$\boxed{\lambda_v \leq 1'38}$ (By Round off)

3 (b) By looking at the solution 3(a) Equation (1) with the increasing value of λ_v at a certain point of time

$R_v(t) \cdot R_{2:3}(t) < R(t)$

we can derive

$\Rightarrow R_v(t) \leq R(t)$

$\Rightarrow e^{-\lambda_v t} \leq e^{-\lambda t}$.

$\Rightarrow \boxed{\lambda_v \geq \lambda_v}$

For TMR we need

$R_{2:3}(t) \geq R(t)$

Where
λ_v = Failure Rate of voter.
λ = Failure rate of single component.

4. <u>Explanation for component could be temporary.</u>

No, the formula not still be correct.

Because in Task 2.5.1 we assume there are no component will be fail or one component will be permanently fail.

But Here the TMR system among component 1, 2 & 3 will be fail for few time. However after certain point of time fail component (1 or 2 or 3) is still going to be working. So, no component fail is permanent. So that is why it is difficult to derive the exact reliability function with Task 2.5.1 formula.