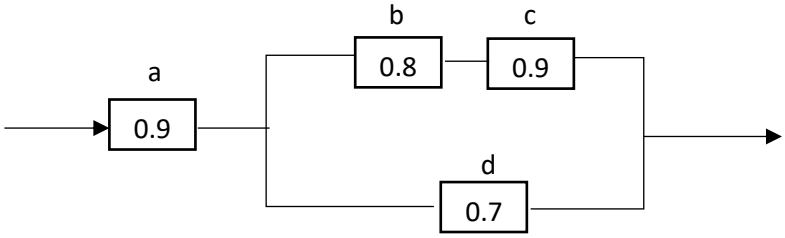
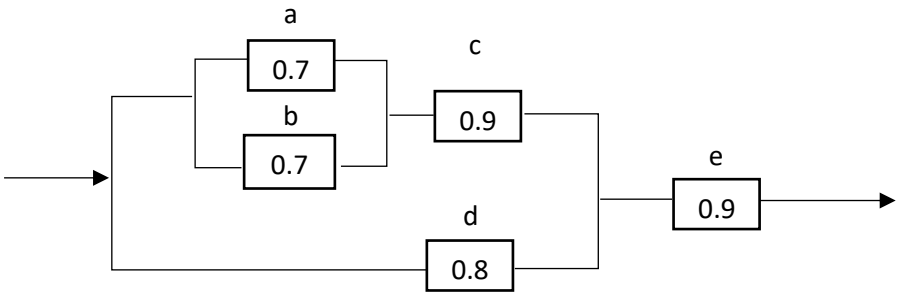
Problems

1. Calculate the system reliability for the units connected as shown



Solve it!

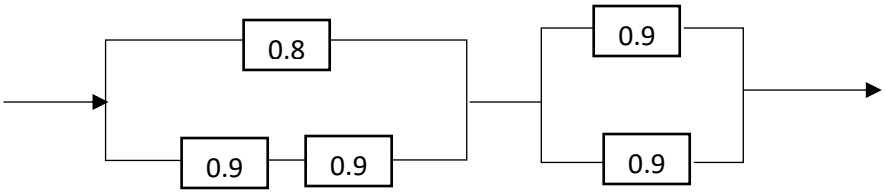
2. Obtain the system reliability



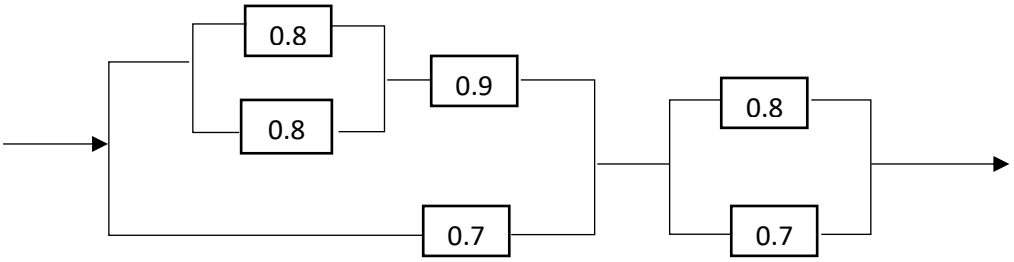
Solve it!

3. Calculate system reliability R_s for following configuration

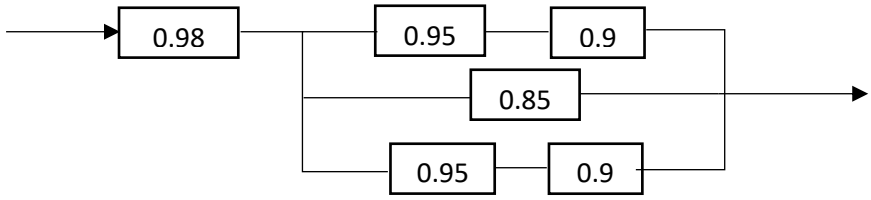
(a).



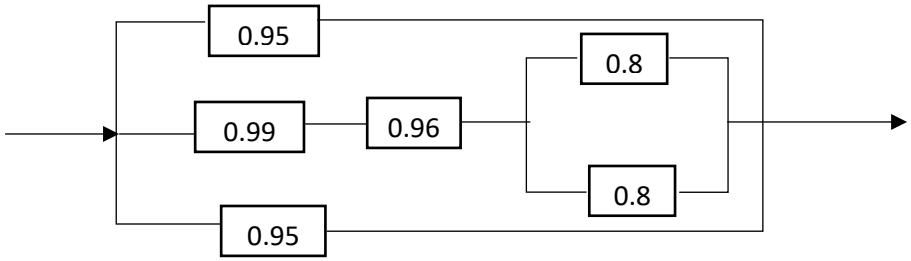
(b).



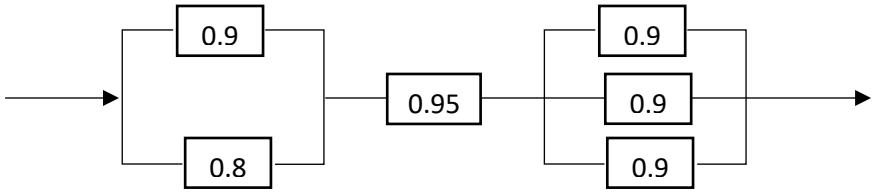
(c).



(d).



(e).



Solve all the above!

4. An equipment consists of 100 parts of which 20 parts are tubes connected functionally in series (Branch A). This branch is in turn connected in series to 2 parallel branches of 20 parts (Branch B) and 60 parts (Branch C). The parts which comprise these branches are connected in series. The reliability of each tube in A is 0.99 while that in B is 0.98 and that in C is 0.94. Calculate the Reliability R_S of the system.

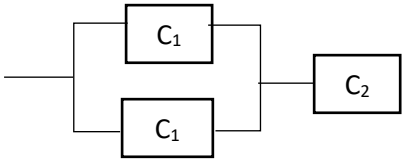
   Solve it!

Consider two components C_1 and C_2 with reliabilities R_1 and R_2 respectively connected as shown below

…… Design 1

then $R_S=R_1R_2$

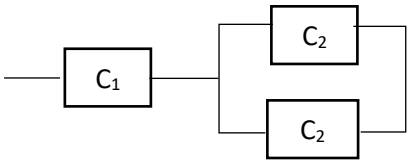
If we replace component C_1 by two parallel components of C_1 as below



…… Design 2

then $R_S = (1-(1-R_1)^2)R_2$
$= (2-R_1)R_1R_2$

Similarly, if we replace component C_2 by two parallel components of C_2 as below



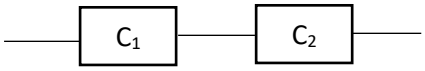
…… Design 3

then $R_S = (1-(1-R_2)^2)R_1$
$= (2-R_2)R_1R_2$

Which design is to be preferred?
If $R_1>R_2$ then Design 3 is preferred.
If $R_2>R_1$ then Design 2 is preferred.

Problems (Contd…)

5. Consider a system with 2 components say C_1 and C_2, having the same cost but with reliabilities $R_1=0.7$ and $R_2=0.95$ as shown below. If we are allowed to add 2 components to the system, would it be preferable to replace component C_1 by 3 components of C_1 in parallel or to replace the components C_1 and C_2 each by simple parallel components.



Solve it!

6. An engineer approximates the reliability of a cutting assembly by

$$R(t) = \begin{cases} \left(1 - \frac{t}{t_0}\right)^2 ; & 0 \le t < t_0 \\ 0 \ ; & t \ge t_0 \end{cases}$$

Determine the failure rate. Does it increase or decrease with time? Also find the MTTF.

Solution:

We have $h(t) = \frac{f(t)}{R(t)}$

where $f(t) = -\frac{d}{dt}[R(t)] = -\frac{d}{dt}\left(1 - \frac{t}{t_0}\right)^2$

$$= \frac{2}{t_0}\left(1 - \frac{t}{t_0}\right); 0 \le t \le t_0$$

$$\therefore \quad h(t) = \frac{\frac{2}{t_0}\left(1-\frac{t}{t_0}\right)}{\left(1-\frac{t}{t_0}\right)^2}$$

$$h(t) = \begin{cases} \frac{2}{t_0}\left(1 - \frac{t}{t_0}\right); & 0 \le t \le t_0 \\ 0 \quad ; & t \ge t_0 \end{cases}$$

Now as time increases the failure rate h(t) increases

since $h(t) = \frac{2}{t_0}; t = 0$

and $h(t) = \infty; t = t_0$

Also, MTTF=$\int_0^\infty R(t)dt = \int_0^{t_0}\left(1 - \frac{t}{t_0}\right)^2 dt = ?$

Obtain it!

7. A device has constant failure rate of 0.02 per hour. Obtain the probability that it will fail during first 10 hours of operations. Suppose the device has been successfully operated for 100 hours, what is the probability that it will fail during next 10 hours of operation? Also give comments.

   Solve it!

8. A critical measuring instrument consists of 2 subsystems A and B connected in series having reliabilities 0.9 and 0.92 respectively, for a certain operating time. It is necessary that reliability of instrument be raised to a minimum value of 0.917 by using parallel subsystems of A alone. Determine how many units of A should be used with one unit of B to get minimum reliability of 0.918. What is the actual value of the reliability obtained? Can you use 2 units of A and 2 units of B to achieve the desired result? What is the reliability of the system now?

   Solve it!

9. The life of an electronic tube is exponentially distributed. It is known that reliability of device for 100 hours period is 0.9. How many hours of operation have considered to achieve a reliability of 0.95?

    Solve it!

10. Suppose that there are 3 components with constant failure rate λ=0.01 connected in parallel. Estimate the improvement in reliability over a period of 10 hours.

    Solve it!

11. Consider a unit having a constant failure rate of 0.3% per 1000 hours. Obtain the MTTF. What are the probabilities of its successful completion of missions of 10,000 hours and 1,00,000 hours.

    Solve it!

12. An airborne electronic system has a radar, computer and an auxiliary unit with MTTFs of 83 hours, 167 hours and 500 hours and equivalent failure rates (in failures per 1000 hours) of 12, 6 and 2 respectively. Find the system reliability and the MTTF for 5 hours operating time. Also find the reliability of subsystems.

    Solve it!

13. Suppose that 2 independently functioning components with failure rates α_1 and α_2 are connected in parallel. Let T be the time to failure of resulting system. Obtain mgf of T.

    Solve it!