

1-A system contains three gas power plant and two hydro power plant with the following parameters:

generating unit	Capacity(MW)	rates
Gas power plant	3*40	Failure rate = 0.01 failures/day Repair rate = 0.49 repairs/day Or $\lambda = 3 f/year$ and $\mu = 97 r/year$
Hydro power plant	2*50	Failure rate = 0.02 failures/day Repair rate = 0.48 repairs/day Or $\lambda = 5 f/year$ and $\mu = 95 r/year$

This system serves a load which on a specified 20-day period has the following model:

Peak load level (MW)	180	120	100	60	0
Number of occurrences	2	5	8	5	20

❖ use the following model for the load.

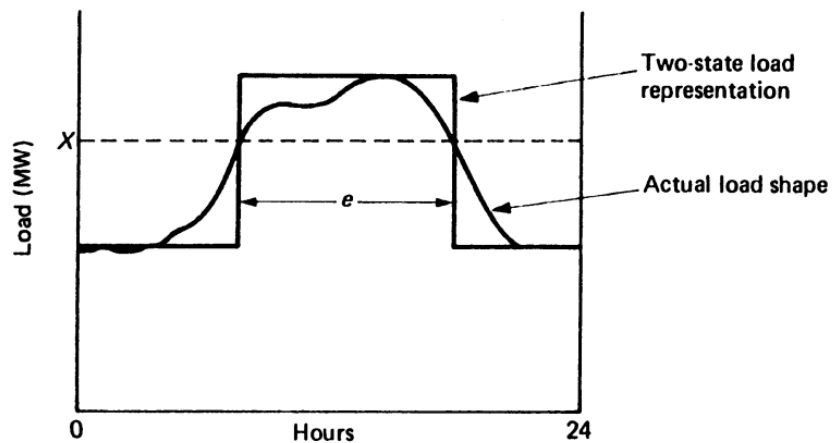


Fig1. Daily load model

	<i>Peak load <math>L_i</math></i>	<i>Low load <math>L_0</math></i>
Mean duration	$e$	$1 - e$
Probability	$p(L_i) = \frac{n(L_i)}{D} e$	$p(L_0) = 1 - e$
Upward load departure rate	$\lambda_+(L_i) = 0$	$\lambda_+(L_0) = \frac{1}{1 - e}$
Downward load departure rate	$\lambda_-(L_i) = \frac{1}{e}$	$\lambda_-(L_0) = 0$
Frequency	$f(L_i) = \frac{n(L_i)}{D}$	$f(L_0) = 1$

Develop a MATLAB or Python program using a recursive algorithm to:

- I. Develop a generation model for this system including both individual and cumulative state probabilities and frequencies.
- II. Develop a complete margin array containing both individual and cumulative state probabilities and frequencies for this system. Assume that the exposure factor is 0.5 and that the 20 days represents a one-period contribution to an annual study.
- III. Calculate the cumulative probability and Cumulative frequency of the first negative margin
- IV. Calculate the LOLE (Loss of Load Expectation)
- V. Now, develop the program solved N non-identical power generation unit

2- Now, develop the program solved in Question 1 for the system with units may include different states. In other words, each unit may have one or more derated or partial-capacity states, in addition to the fully operational (up) and fully out-of-service (down) states.

Note: All parts of question one should also be answered here.

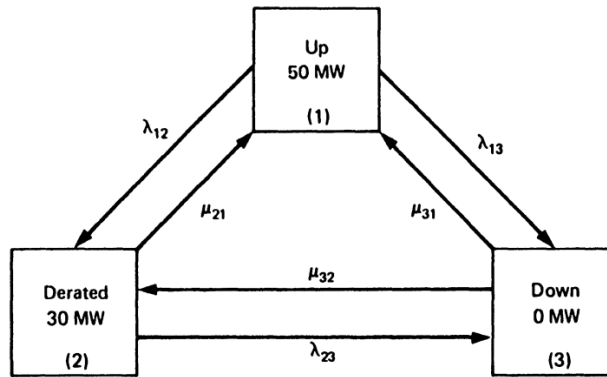


fig.2 Three-state unit model

❖ For example

generating unit	Capacity(MW)	rates
Gas power plant	Up state: 3*40 Derated stae: 3*30 Down stae: 3*0	$\lambda_{13} = 0.022$ occ/day $\lambda_{12} = 0.008$ $\lambda_{23} = 0.019$ $\mu_{31} = 2.94$ $\mu_{21} = 0.25$ $\mu_{32} = 0.171$
Hydro power plant	Up state: 2*50 Derated stae: 2*25 Down stae: 2*0	$\lambda_{13} = 0.02$ occ/day $\lambda_{12} = 0.03$ $\lambda_{23} = 0.02$ $\mu_{31} = 2.8$ $\mu_{21} = 0.3$ $\mu_{32} = 0.2$

$$P_{up} = \frac{A}{D}$$

$$P_{down} = \frac{B}{D}$$

$$P_{derated} = \frac{C}{D}$$

$$A = \mu_{31} \mu_{21} + \mu_{31} \lambda_{23} + \mu_{32} \mu_{21}$$

$$B = \lambda_{13} \mu_{32} + \lambda_{12} \mu_{32} + \lambda_{12} \mu_{31}$$

$$C = \lambda_{12} \lambda_{23} + \lambda_{12} \lambda_{13} + \lambda_{13} \lambda_{23}$$

$$D = A + B + C$$

generating unit	Capacity(MW)	
Gas power plant	Up state: 3*40 Derated stae: 3*30 Down stae: 3*0	$\lambda = 3 f/year$ and $\mu = 97 r/year$ $\lambda_{derated} = 5 f/year$ and $\mu_{derated} = 95 r/year$
Hydro power plant	Up state: 2*50 Derated stae: 2*25 Down stae: 2*0	$\lambda = 5 f/year$ and $\mu = 95 r/year$ $\lambda_{derated} = 7 f/year$ and $\mu_{derated} = 93 r/year$