



Please, answer All the following Questions, Exam is in 2 pages

Question 1

[20 Marks]

- (a) What are the different variables that are generally estimated in power system? Compare in Table between different types of state estimation.
- (a) You are given the following network with meters at locations as shown in Figure 1. here line impedances (per unit) are as follows: $X_{12}=0.25$, $X_{13}=0.35$, $X_{23}=0.45$ and $X_{24}=0.1$. Bus conditions are as follows: load at bus 1 = 50 MW, load at bus 2= 120 MW, generation on bus 3 = 90 MW, and generation on bus 4 = 80 MW. While measurements values (MW) are as follows: $M_{13}=-69.5$, $M_{31}=71.9$, and $M_{12} = 19.4$. Measurement errors are as follows: $\sigma_{13}= 0.01$, $\sigma_{31}= 0.012$, and $\sigma_{12}= 0.015$.

- I. Is this network observable? If it is observable solve for θ_1 , θ_2 and θ_3 , considering θ_4 as a reference.
- II. Suppose we had a measurement of generation output at bus 3 with value of 90 MW and error of 0.015. include this measurement in our measurement set and repeat part (I)

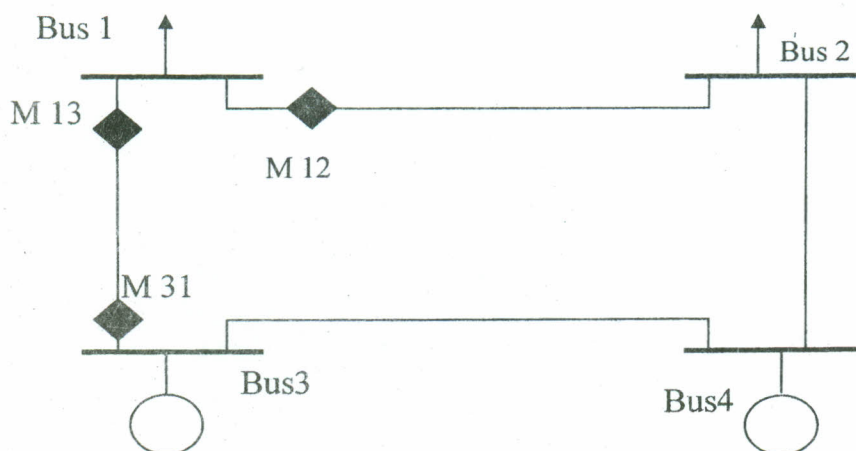


Figure 1

Question 2

[20 Marks]

- (a) What are the major reliability indices ? define three of them? What is the best index among them?
- (b) A generating system consists of the following units:
- | | |
|-----------------|-------------------|
| 2 X 60 MW units | FOR of 1.5% each, |
| 1 X 40 MW unit | FOR of 2 % and |
| 2 X 20 MW units | FOR of 3% each |

Calculate for one day the Loss of Load Expectation, Loss of load Probability and the Expected Energy not supplied for the following daily load curve:

160 MW from Midnight to 4 PM and
100 MW from 4 PM to 12 Midnight

Question 3

[15 Marks]

- (a) Define the short run marginal cost, long run marginal cost and the differences between them.
- (b) State the Ramsey pricing for several groups of consumers.
- (c) Draw each of the possible power market models showing the main feature of each model.