b) Obtain the polar plot for the transfer function G(s) H(s) = $\frac{20}{s(s+1)(s+2)}$. (10 marks)

14. a) Draw the Nyquist plot and asses the stability of the closed loop system whose open loop transfer function is G(s) H(s) = $\frac{s+4}{(s+1)(s-1)}$ (10 marks)

b) Explain the method of finding relative stability using polar plot with an example (10 marks)

MODULE III

15. a) Given a system G(s) = $\frac{K}{s(s+2)(s+20)}$. Design a lag compensator to have the phase margin to be at least 35^0 and velocity error constant less than or equal to 40. (10 marks)

b) Discuss about various rules for PID controllers (10 marks)

16. Sketch the root locus of the open loop transfer function given by G(s) H(s) = $\frac{K}{s(s+2)(s^2+2s+5)}$ (20 marks)

MODULE IV

17. a) A linear time invariant system is characterised by the state variable model $\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\end{bmatrix} = \begin{bmatrix}-1 & 0\\ 0 & -2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u$ y(t)= $\begin{bmatrix}1 & 2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$. Comment on controllability and observability of the system (10 marks)

b) Obtain the transfer function from the system defined by

$$\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\\ \dot{x_3}\end{bmatrix} = \begin{bmatrix}-1 & 1 & 0\\ 0 & -1 & 1\\ 0 & 0 & -2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u \qquad y(t) = \begin{bmatrix}1 & 0 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$ (10 marks)

18. a)Obtain the state space representation of the system defined by

$$\frac{Y(s)}{U(s)} = \frac{s}{(s+10)(s^2+4s+16)}$$ (10 marks)

b) Obtain the step response of the system defined by

$$\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u$$ (10 marks)