Questions raised during break or after lecture – 29 Sept 2015

1. Do we use frequency response method because finding the response using Laplace transform method is too difficult for sinusoidal input.

Response: No.
We use frequency response method when it is required and it can be used. If the interest is to find the steady-state output for sinusoidal input, then we can use frequency response method. Frequency response method can't be used to find transient response.

2. Can we use frequency response method to find output for other types of input?

Response: Not directly.
If the input signal is periodic, it can be decomposed into sum of sines and cosines using Fourier series. Then we can apply frequency response to find steady-state response for each of the sine and cosine signals. The overall response is sum of the individual responses.
Clearly, this is not so convenient.
The situation is worse for non-periodic input as the Fourier transform will result in infinite number of constituent sine and cosine waveforms.

3. Why substituting $s=j\omega$ in $G(s)$ gives the frequency response?

Response:
For details, you may refer to Appendix 1-A. It is shown there that modulus of $G(j\omega_i)$ is equal to the gain $M(\omega_i)$ at that frequency and the argument of $G(j\omega_i)$ is equal to the phase $\phi(\omega_i)$.

4. Do we have to memorize the derivations in pages 11-13 of Chapter 1?

Response: NO.
The derivations follow what you learnt in the first half of the module, i.e., how to find the response of a linear system. The objective is the reach the conclusion depicted in the diagram shown on page 14.

5. In root locus, we find marginal stability by solving $1+KG_{OL}(s)=0$ for $s = j\omega_0$. Is it related to frequency response?

Response: Root locus and frequency response are different things. But there is a connection if the root locus intersects the imaginary axis resulting in a marginally stable closed loop.

Any point on the root locus is a closed loop pole for specific value of K. If there exists a K for which the closed loop pole is imaginary then the root locus intersects the imaginary axis. And you find that condition by solving $1+KG_{OL}(j\omega)=0$.

If this condition is satisfied then there is $\omega=\omega_0$ for which $1+KG_{OL}(j\omega_0)=0$

That is to say, $KG_{OL}(j\omega_0)=-1$

However, $KG_{OL}(j\omega)$ is the frequency response of the transfer function $KG_{OL}(s)$. Therefore, $KG_{OL}(j\omega_0)$ is the open loop frequency response at the frequency $\omega=\omega_0$.

$$KG_{OL}(j\omega_0)=-1 \quad \Rightarrow \quad M(\omega_0)=1, \phi(\omega_0)=\pm 180^\circ$$

If there exists any frequency $\omega=\omega_0$ at which open loop gain is 1 and phase is $\pm 180^\circ$, then the resulting closed loop will have poles on the imaginary axis, i.e., the closed loop is marginally stable. If you have studied oscillator circuits, this is the condition for sustained oscillation. We also encounter this condition in audio systems when the microphone picks up signal from the speaker satisfying the condition above.