

27/07/2020

design for robustness

Week 7: Quantitative feedback theory (Part 1/2)

Week 8 : Quantitative feedback theory (Part 2/2)

Lecture Notes(Week 1 -8)

Week 9: Fundamental properties of feedback systems

Week 10 :Nonminimum phase system

Week 11: Unstable systems

Week 12 Describing functions

 Describing functions (Part 1/2)

 Describing functions (Part 2/2)

 Quiz : Week 12 Assessment

Week 12
 Lecture Notes

Assignment solutions

Control System Design - - Unit 18 - Week 12 Describing functions

4) The response of a non-linear system to a sinusoidal input signal $r(t) = A sin\omega t$ is given **1 point** by a periodic signal x(t). Further, the sinusoidal input describing function for the non-linear system is

given as $DF(\omega, A) = \frac{j}{\pi A} \int_0^{2\pi} x(\theta) e^{-j\theta} d\theta$. Identify the correct statement from below which describes the describing function

- The ratio of output signal x(t) to input signal r(t).
- The ratio of maximum magnitude of output signal x(t) to the magnitude of input signal r(t).
- The ratio of phase of output signal x(t) to magnitude of input signal r(t)
- The ratio of first harmonic component of x(t) to the amplitude of the input signal r(t)

No, the answer is incorrect.

Score: 0

Accepted Answers: The ratio of first harmonic component of *x*(*t*) to the amplitude of the input signal *r*(*t*)

5) The describing function for a system with static non-linearity dependent only on:

- Frequency of input sinusoidal signal
- The amplitude of the input sinusoidal signal.

Phase of the input sinusoidal signal.

Polarity of the input sinusoidal signal.

No, the answer is incorrect.

Score: 0

Accepted Answers: The amplitude of the input sinusoidal signal.

6) Obtain the describing function of a system whose input-output relationship is given below. **1** point Consider the applied sinusoidal input to be $x(t) = Asin\omega t$. (Given A>s)

$$\frac{2K}{\pi} [sin^{-1}\frac{s}{A} + \frac{s}{A}\sqrt{1 - (\frac{s}{A})^2}]$$

$$\frac{2K}{\pi} [cos^{-1}\frac{s}{A} + \frac{s}{A}\sqrt{1 - (\frac{s}{A})^2}]$$

$$\frac{2K}{\pi} [sin^{-1}\frac{s}{A} + \frac{s}{A}\sqrt{(\frac{s}{A})^2} - 1]$$

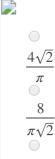
$$K$$

No, the answer is incorrect. Score: 0

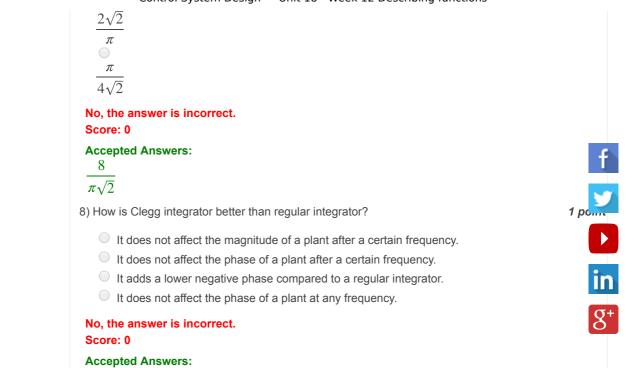
Accepted Answers:

$$\frac{2K}{\pi} [\sin^{-1}\frac{s}{A} + \frac{s}{A}\sqrt{1 - (\frac{s}{A})^2}]$$

7) A linear plant whose input (u_1) is related to its output (x_1) is related as $x' + x = u_1$ is **0** points actuated by an ON-OFF controller whose input (u) is related to its output (u_1) as shown below. Given that the applied sinusoidal input is u(t)=0.5sint, the describing function of the overall system (actuator and plant combination) at the frequency of the applied input is



f V V



9) If $G(j\omega)$ is the open-loop transfer function of the system and $DF(A, \omega)$ is the describing **1** point function of a single nonlinearity in the forward path. Then the condition under which we would have sustained oscillations in the system will be:

It adds a lower negative phase compared to a regular integrator.

$$G(j\omega) \ge DF(A, \omega)$$

$$G(j\omega)DF(A, \omega) = -1$$

$$G(j\omega)DF(A, \omega) = 0$$

$$G(j\omega)DF(A, \omega) = 1$$

No, the answer is incorrect. Score: 0

Accepted Answers: $G(j\omega)DF(A, \omega) = -1$

10 How does one go about control system design in presence of non-linearity cascaded with the **1** point loop gain L(s)?

Identify the describing function of the non-linear system, calculate the set of values of describing function $(DF(A, \omega))$. Then design $DF(A, \omega)L(j\omega)$ such that the open-loop system possesses adequate phase margin even for the worst case.

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Identify the describing function of the non-linear system, calculate the value of describing function $DF(A, \omega)$ for the least expected swing A. Then design $DF(A, \omega)L(j\omega)$ such that the open-loop system possesses adequate phase margin for this case.

Identify the describing function of the non-linear system, calculate the value of describing function $DF(A, \omega)$ for the largest swing A. Then design $DF(A, \omega)L(j\omega)DF(A, \omega)L(j\omega)$ such that the open-loop system possesses adequate phase margin for this case.

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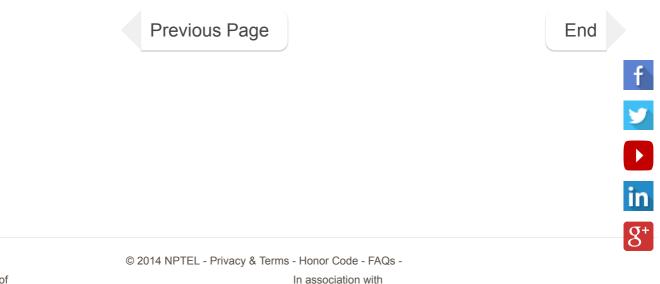
Design $L(j\omega)$ such that the open-loop system possesses adequate phase margin regardless of the effect of nonlinearity.

No, the answer is incorrect. Score: 0

Accepted Answers:

Control System Design - - Unit 18 - Week 12 Describing functions

Identify the describing function of the non-linear system, calculate the set of values of describing function $(DF(A, \omega))$. Then design $DF(A, \omega)L(j\omega)$ such that the open-loop system possesses adequate phasmargin even for the worst case.







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