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reviewer3@nptel.iitm.ac.in ▼

Courses » Control System Design

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Unit 18 - Week 12 Describing functions

Week 12 Assessment

The due date for submitting this assignment has passed. **Due on 2018-10-24, 23:59 IST.**
As per our records you have not submitted this assignment.

1) The relationship between input r and output x for a system is shown below: ***1 point***

Identify the correct type of nonlinearity:

- Quantization
- Hysteresis
- Saturation
- Deadzone

No, the answer is incorrect.
Score: 0

Accepted Answers:
Hysteresis

2) The most appropriate signal for characterizing a non-linear system is a sinusoidal signal because: ***1 point***

- By sweeping the frequency of the sinusoidal signal we can determine the frequency after which the system becomes unstable.
- The response of a non-linear system to sinusoidal input is a sinusoidal output itself.
- If a system is on the verge of instability its response is a slowly decaying sinusoidal signal.
- A non-linear system behaves like a linear system for sinusoidal input.

No, the answer is incorrect.
Score: 0

Accepted Answers:
If a system is on the verge of instability its response is a slowly decaying sinusoidal signal.

3) The response x(t) of a non-linear system to a sinusoidal input $r(t) = Asin\omega_0 t$, where ω_0 is close to gain cross-over frequency of the system is a periodic signal. However, in order to characterize the non-linear system, we consider only the first harmonic component because ***1 point***

- The higher harmonic components are rejected because their magnitudes are attenuated.
- The higher harmonic components are rejected because their magnitudes are amplified.
- The higher harmonic components are rejected because their magnitudes are linearly dependent on the first harmonic component.
- The higher harmonic components are rejected because their magnitudes are linearly independent on the first harmonic component.

No, the answer is incorrect.
Score: 0

Accepted Answers:
The higher harmonic components are rejected because their magnitudes are attenuated.

4) The response of a non-linear system to a sinusoidal input signal $r(t) = Asin\omega t$ is given 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 *1 point*

- 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: *1 point*

- 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. Consider the applied sinusoidal input to be $x(t) = Asin\omega t$. (Given A>s) *1 point*

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

- $\frac{4\sqrt{2}}{\pi}$
- $\frac{8}{\pi\sqrt{2}}$
-

$\frac{2\sqrt{2}}{\pi}$

$\frac{\pi}{4\sqrt{2}}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{8}{\pi\sqrt{2}}$

8) How is Clegg integrator better than regular integrator? *1 point*

- It does not affect the magnitude of a plant after a certain frequency.
- It does not affect the phase of a plant after a certain frequency.
- It adds a lower negative phase compared to a regular integrator.
- It does not affect the phase of a plant at any frequency.

No, the answer is incorrect.
Score: 0

Accepted Answers:
It adds a lower negative phase compared to a regular integrator.

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

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

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

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

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

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 loop gain L(s)? *1 point*

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.

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.

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:

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 phas margin even for the worst case.

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