MECH307 EXAM 2 - Example Questions

NAME: _____

NOTE:

- THE ONLY INFO REQUIRED ON THE SCANTRON SHEET IS YOUR NAME, CSU ID # (NOT SSN), AND ANSWER DOTS. **THERE WILL BE A PENALTY IF THE DOTS FOR YOUR LAST NAME AND CSU ID # ARE NOT CORRECT.**
- CLOSED BOOK, CLOSED NOTES. SOME REFERENCE INFORMATION IS PROVIDED.
- **NO ELECTRONIC DEVICES ALLOWED** (CALCULATOR, CELL PHONE, PDA, MUSIC PLAYER, ETC.). THE ONLY AIDS ALLOWED ARE A PENCIL AND AN ERASER.
- DO YOUR WORK ON THE EXAM ONLY (NO SCRATCH PAPER ALLOWED).
- **PLEASE REMOVE YOUR HAT OR TURN IT SO YOUR FACE AND EYES ARE VISIBLE.**
- "ROAMING EYES" WILL NOT BE TOLERATED.
- READ THE QUESTION AND ALL ANSWERS CAREFULLY AND SELECT THE **BEST** ANSWER.
- ALL QUESTIONS ARE WEIGHTED EQUALLY.
- **NOTE** - THE DOTS ON YOUR SCANTRON SHEET INDICATE YOUR OFFICIAL ("FINAL") ANSWERS, SO BE CAREFUL WHEN YOU FILL THEM IN. ALSO, IF YOU WAIT UNTIL THE END TO FILL IN THE DOTS, MAKE SURE YOU ALLOCATE ENOUGH TIME FOR THIS TASK.

USEFUL EQUATIONS AND FIGURES:

1st-Order System:

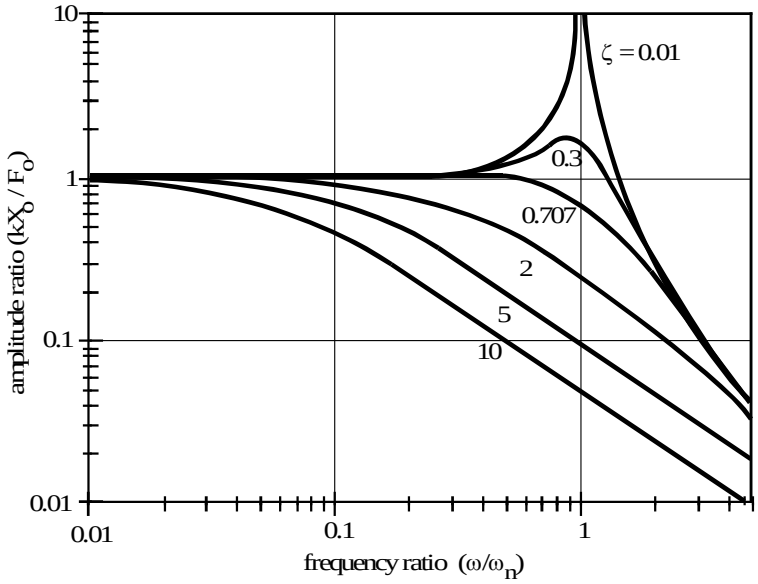
$$\tau\frac{dX_{out}}{dt} + X_{out} = KX_{in} \qquad \text{step response: } X_{out}(t) = KA_{in}(1 - e^{-t/\tau})$$

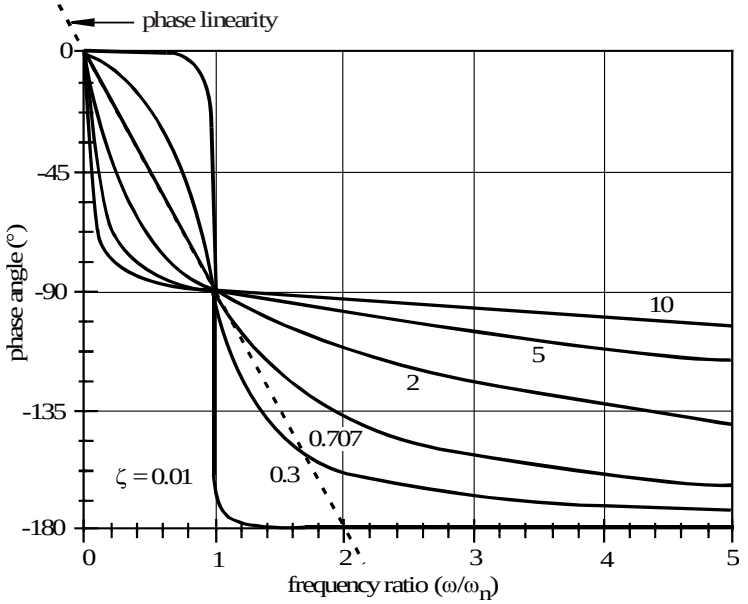
2nd-Order System:

$$m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + kx = F_{ext}(t)$$

$$\omega_n = \sqrt{\frac{k}{m}} \qquad \zeta = \frac{b}{b_c} \qquad b_c = 2m\omega_n$$

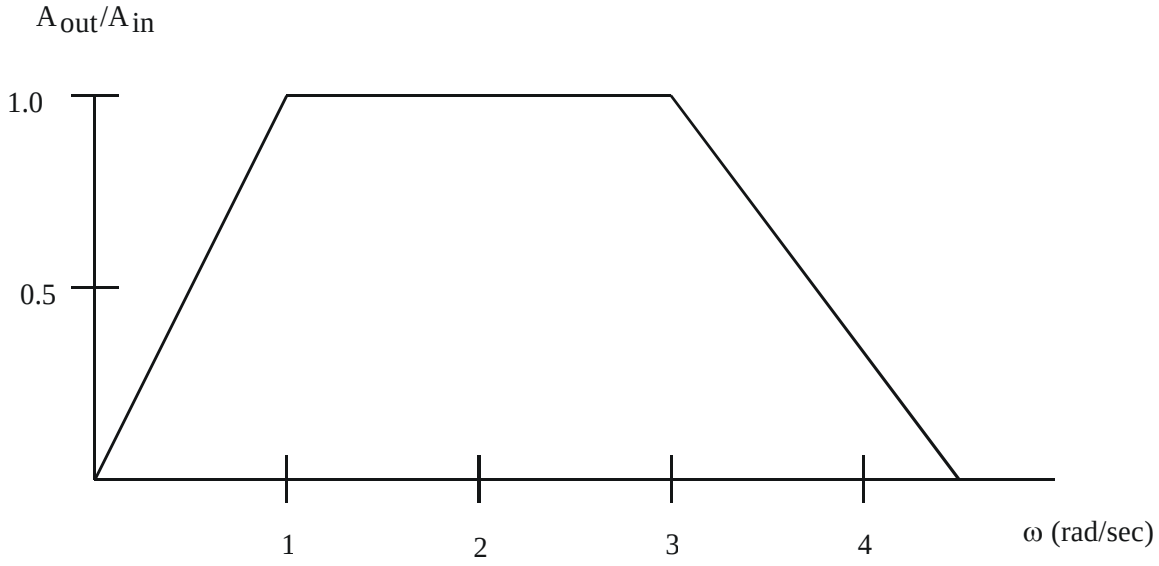
frequency response: $\frac{X_o}{F_o/k} = \frac{1}{\left(\left[1-\left(\frac{\omega}{\omega_n}\right)^2\right]^2 + 4\zeta^2\left(\frac{\omega}{\omega_n}\right)^2\right)^{1/2}}$ $\qquad \phi = -\tan^{-1}\left(\frac{2\zeta}{\frac{\omega_n}{\omega} - \frac{\omega}{\omega_n}}\right)$





(1) A "good" measurement system exhibits
   (a) amplitude linearity, large bandwidth, and phase linearity
   (b) amplitude linearity, small bandwidth, and constant phase
   (c) amplitude linearity, large bandwidth, and constant phase
   (d) amplitude linearity, small bandwidth, and phase linearity

Questions 2 through 4 deal with a measurement system with a frequency response as shown below:



(2) What is the bandwidth of the system
   (a) 0 rad/sec to 4.5 rad/sec
   (b) 1 rad/sec to 3 rad/sec
   (c) 0.707 rad/sec to 3.439 rad/sec
   (d) 0.707 rad/sec to 3.707 rad/sec
   (e) 0.707 rad/sec to 4.5 rad/sec

(3) If the system is used to measure a sinusoidal input of frequency 0.5 rad/sec and of amplitude 2 V, the output will have an amplitude of
   (a) 0 V
   (b) 0.5 V
   (c) 1 V
   (d) 2 V
   (e) 2.5 V

(4) For all input frequencies above 4.5 rad/sec, the system output amplitude will be
   (a) attenuated, but nonzero
   (b) amplified
   (c) 1
   (d) 0
   (e) negative

(5) What is the natural frequency, in Hertz, of an undamped 2nd order spring-mass system with m=100 grams and k = 100 N/m?
(a) $1/(2\pi)$
(b) 2π
(c) $31.62/(2\pi)$
(d) $2\pi/31.62$
(e) $1000/(2\pi)$

(6) For low frequencies, the frequency response of a second order system predicts that the output will be out of phase from the input by
(a) 0°
(b) 90°
(c) 180°
(d) –90°
(e) –180°

(7) Current in an electrical system is analogous to what in a hydraulic system?
(a) pressure
(b) volumetric flow rate
(c) mass flow rate
(d) volume
(e) fluid momentum

(8) The current into the inverting input terminal of an ideal op amp is always
(a) zero
(b) nonzero and the negative of the current into the noninverting input terminal
(c) the same as the output current
(d) positive
(e) negative

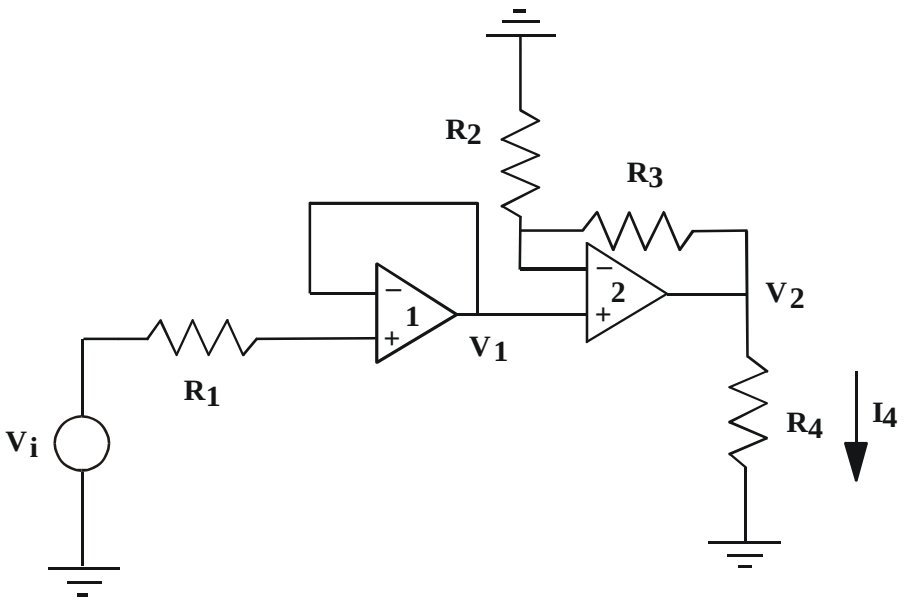
(9) The closed-loop gain of an inverting amplifier circuit is
(a) positive
(b) negative
(c) zero
(d) almost infinite for an ideal op amp

(10) If a shunt resistor is placed in parallel with the feedback capacitor of an ideal integrator circuit, the resulting circuit works well (integrates properly) only when the input frequency components are:
(a) very low
(b) mid range
(c) low and high, but not mid range
(d) low and mid range, but not very high
(e) very high

(11) What is the approximate maximum output voltage swing for a 741 op amp powered by a ±15 V supply?

(a) 0 to 15 V
(b) 0 to 13.6 V
(c) –15 to 15 V
(d) –13.6 to 13.6 V
(e) –13.6 to 15 V

Questions 12 through 14 deal with the circuit below where the op amps are LM741's powered by a ±15 V power supply. Assume $R_1 = R_2 = R_3 = R_4 = R$.



(12) If $V_i = 1$ V, V_1 would be

(a) 0 V
(b) 1 V
(c) 13.6 V
(d) 2 V

(13) If $V_1 = 1$ V, V_2 is

(a) 0 V
(b) 1 V
(c) 2 V
(d) – 2 V
(e) – 1 V

(14) If $V_2 = 2$ V, the current output by op amp 2 is

(a) 0
(b) 1 / R
(c) 2 / R
(d) 3 / R
(e) 2 / 3R

(15) The sampling rate for standard audio CD technology is approximately 44 kHz because the highest frequency a human (with good hearing) can hear is approximately
(a) 20 Hz
(b) 10 kHz
(c) 20 kHz
(d) 40 kHz
(e) 80 kHz

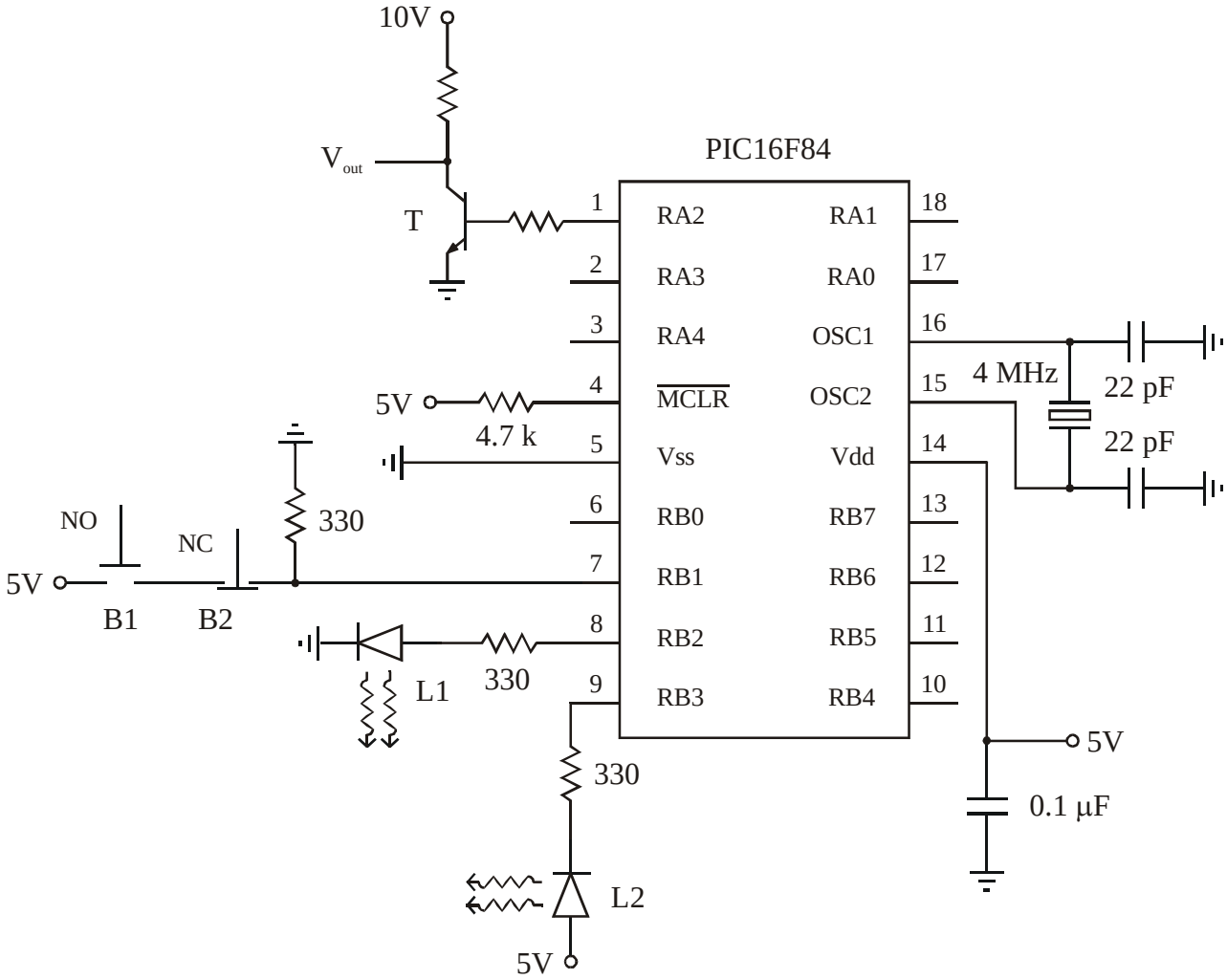
(16) If a 100 kHz sine wave is sampled at 25 kHz, the resulting signal will exhibit
(a) attenuation
(b) high fidelity
(c) amplification
(d) inversion
(e) aliasing

(17) If we sample a signal at 100 Hz, the Sampling Theorem states that the resulting output will be acceptable only if the highest frequency component in the signal is
(a) greater than 200 Hz
(b) less than 200 Hz
(c) greater than 50 Hz
(d) less than 50 Hz
(e) exactly equal to 100 Hz

(18) How many different output states can a 5 bit A/D converter represent?
(a) 5
(b) 10
(c) 25
(d) 31
(e) 32

(19) What is the voltage quantization size for a 4-bit A/D converter operating over a 30 V voltage range?
(a) 0.25 V
(b) 1.875 V
(c) 2 V
(d) 4 V
(e) 7.5 V

Questions 20 through 29 deal with the figure below. Assume all outputs are low to begin with unless indicated otherwise.



(20) What does the following PICBASIC code do?

HIGH PORTB.2

(a) turns on LED L1
(b) turns off LED L1

(21) What does the following PICBASIC code do?

LOW PORTB.2

(a) turns on LED L1
(b) turns off LED L1

(22) What does the following PICBASIC code do?

HIGH PORTB.3

(a) turns on LED L2
(b) turns off LED L2

(23) What does the following PICBASIC code do?

```
LOW PORTB.3
```

(a) turns on LED L2
(b) turns off LED L2

(24) After the following PICBASIC code, what will be the approximate value for V_{out}?

```
HIGH PORTA.2
```

(a) 0 V
(b) 10 V
(c) -10 V
(d) 5 V
(e) -5 V

(25) After the following PICBASIC code, what will be the approximate value for V_{out}?

```
LOW PORTA.2
```

(a) 0 V
(b) 10 V
(c) -10 V
(d) 5 V
(e) -5 V

(26) If buttons B1 and B2 are both being held down, what is the value for PORTB.1?
(a) 0
(b) 1

(27) If buttons B1 and B2 are both being held down, what does the following PICBASIC code do?

```
IF (PORTB.1 == 1) THEN
    HIGH PORTB.2
ELSE
    LOW PORTB.2
```

(a) turns on LED L1
(b) turns off LED L1

(28) If button B1 is held down and B2 is up (i.e., not pressed), what is the value for PORTB.1?
(a) 0
(b) 1

(29) If button B1 is up (i.e., not pressed) and B2 is held down, what is the value for PORTB.1?
(a) 0
(b) 1

(30) In PICBASIC, what is the equivalent base ten value for (%100 + %100)?
(a) 4
(b) 8
(c) 16
(d) 100
(e) 200

(31) In PICBASIC, what is the equivalent base ten value for ($10 + $10)?
(a) 10
(b) 16
(c) 20
(d) 32
(e) 64