



Answer All the following questions:

Question – 1: For the circuit shown in Figure 1, if the UJT parameters are given as $V_s = 10\text{ V}$, $\eta = 0.7$, $I_P = 5\text{ }\mu\text{A}$, $V_V = 0.5\text{ V}$ and $I_V = 5\text{ mA}$, the frequency of oscillation is $f = 50\text{ Hz}$ and the width of the pulse trigger $= 50\text{ }\mu\text{sec}$.

- Sketch the voltage signal V_E and V_{B1} .
- Design the circuit such that the firing angle of SCR $\alpha = 40^\circ$.
- What is the problem of the circuit? How to modify the circuit to overcome that problem?
 Draw the modified circuit diagram.

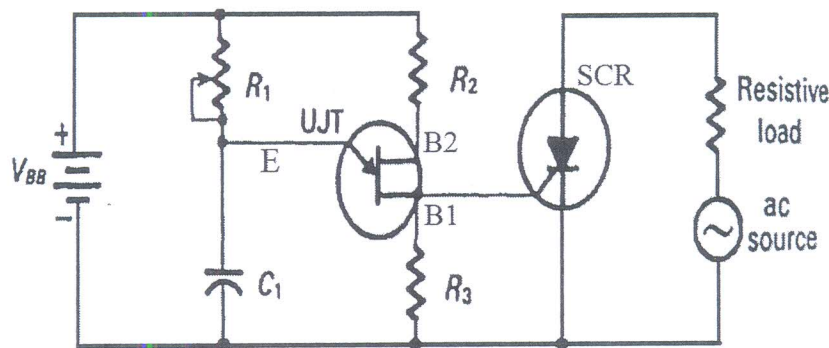


Figure 1

[10 Marks]

Question – 2:

[15 Marks]

A) For the circuit shown in Figure 2, a $5\text{ k}\Omega$ load resistance is supplied from a 200 V , 50 Hz supply voltage. From the data sheet: the SCR triggering pulse should have amplitude of 15 V and duration $30\text{ }\mu\text{sec}$. The parameters of PUT are: $V_s = 25\text{ V}$ and $I_G = 0.5\text{ mA}$,

- What is the advantage of using PUT over UJT for pulse triggering?
- Sketch the waveforms of the voltage across zener diode, the capacitor, the resistance R_4 , the load voltage and the voltage across SCR.
- If the delay angle of the SCR is to be controlled in the range from 25° to 180° , Find V_z and all circuit parameters.

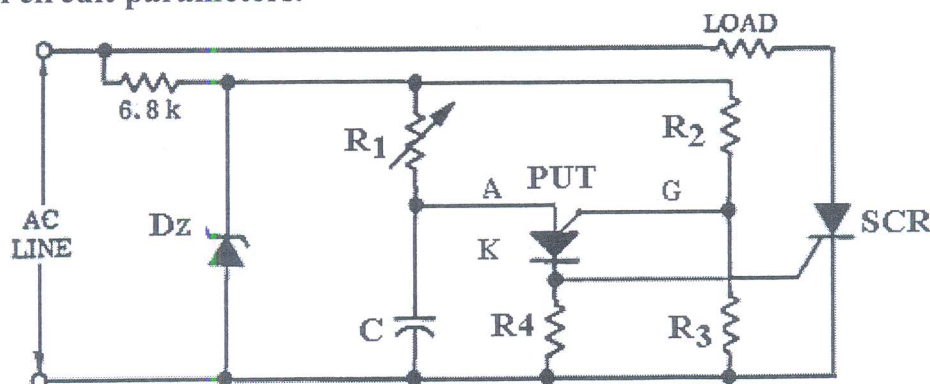


Figure 2

[10 Marks]

B) For the full-wave RC phase shifter triggering circuit shown in Figure 3, draw the voltage signals of v_s , v_d , v_C , v_O , v_T

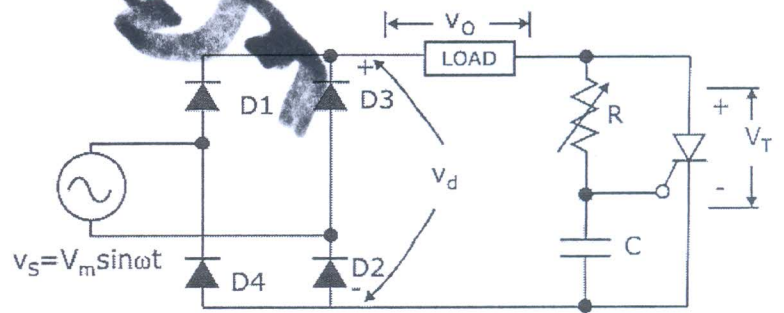


Figure 3

[5 Marks]

Question – 3: For the circuit shown in Figure 4 the supply voltage is 120 V, 60 Hz, a load resistance of 100 Ω, and inductance of 500 mH. If the firing delay angle of the thyristor T_1 is selected to be 45° , and the conduction angles is 200° . Assume SCR to be ideal.

- Sketch the supply voltage, triggering signals of T_1 , thyristor current and load voltage.
- Derive an expression for the output (inductive load) current.
- Determine the average (DC) load voltage.
- Find the normalized DC output load voltage.
- What is the function of the diode?

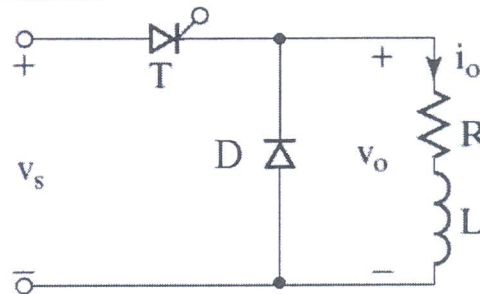


Figure 4

[12 Marks]

Question – 4: For the circuit shown in Figure 5, the input AC supply voltage is 230 V, 50 Hz and a resistive load of 20 Ω. If a firing angle of 45° is to be used to control the output voltage:

- Sketch the supply voltage, triggering signals, load voltage and current waveforms.
- Determine the RMS output voltage.
- Determine the output AC power delivered to the load.
- Determine the input power factor.
- Find the average and RMS thyristor currents.
- What is the problem of this circuit? Explain with drawing the circuit diagram how to modify the circuit to overcome this problem?

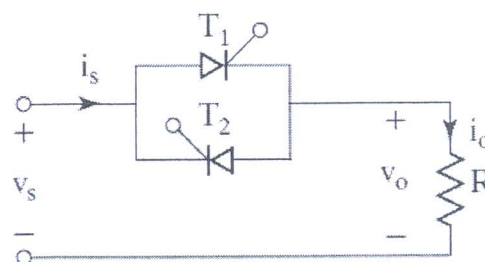


Figure 5

[13 Marks]

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Examiner: Dr. Essam Nabil



Answer all the following questions

[Total Marks: 50]

First question: [15]

(A) Suppose that $f(x) = e^{-x}$ for $x > 0$, check the probability density function, then determine the following probabilities:

- (i) $P(X < 1)$ (ii) $P(1 \leq X < 2.5)$ (iii) $P(X = 3)$ (iv) $P(X \geq 3)$

(B) The joint density for the random variables (X, Y) , where X is the unit temperature change and Y is the proportion of spectrum shift that a certain atomic particle produces, is

$$f(x, y) = \begin{cases} 10xy^2, & 0 < x < y < 1 \\ 0, & \text{elsewhere.} \end{cases}$$

(i) Find the marginal densities $g(x)$, $h(y)$, and the conditional density $f(y|x)$.

(ii) Find the probability that the spectrum shifts more than half of the total observations, given that the temperature is increased by 0.25 unit.

(C) For a certain manufacturing process, it is known that, on the average, 1 in every 100 items is defective. What is the probability that the fifth item inspected is the first defective item found?

Second question: [15]

(A) Find all value of z such that: $\cos z = 2$.

(B) Solve the equation $z^4 + 16 = 0$.

(C) Evaluate $\int_C \bar{z} dz$ where $C: |z - 1| = 2$.

(D) Evaluate $\int_C \frac{\sin \pi z^2 + \cos \pi z^2}{(z - 1)(z - 3)} dz$ where $C: |z| = 2$, positively oriented.

(E) Evaluate $\int_C \left[\frac{e^{2z}}{(z + 1)^4} \right] dz$ where $C: |z| = 3$, positively oriented.

Third question: [20]

Choose the correct answer

1. Find the value of $\text{Log}(-6)$.

A) $\log 6 + i\pi$

B) $\log 36 + i\pi$

C) $\log 6 + i3\pi$

D) $\log 6 + i2\pi$

2. Represent Principle value of i^i terms of e .

A) $e^{-\frac{\pi}{2}}$

B) $e^{-\frac{3\pi}{2}}$

C) $e^{-\frac{\pi}{6}}$

D) $e^{-\frac{\pi}{3}}$

3. If $u(x, y) = x^2 - y^2$ is harmonic function, then the conjugate harmonic function is

A) $2xy$

B) $-x^2 - y^2$

C) $y^2 - x^2$

D) $x^2 + y^2$

4. The value of $\int_0^{1+i} z^2 dz$ along $x = y$ is given by

A) $\frac{2}{3}(i + 1)$

B) $\frac{2}{3}(i - 1)$

C) $-\frac{2}{3}i$

D) $-\frac{2}{3} - \frac{2}{3}i$

5. Necessary and sufficient condition for $w = f(z)$ to be analytic in region R is

A) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$ and $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial x}$

B) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$ and $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$

C) $\frac{\partial u}{\partial x} = -\frac{\partial v}{\partial y}$ and $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$

D) $\frac{\partial^2 u}{\partial x^2} = \frac{\partial v}{\partial y}$ and $\frac{\partial u}{\partial y} = \frac{\partial^2 v}{\partial x^2}$

6. If A and B are two independent events. And $P(A) = 0.2$, $P(A \cap B) = 0.06$, determine $P(B|A)$.

A) 0.1

B) 0.3

C) 0.6

D) 0.9

7. If X and Y are random variables with variances $\sigma_x^2 = 2$, and $\sigma_y^2 = 4$, and covariance $\sigma_{XY} = -2$, find the variance of the random variable $Z = 3X - 4Y + 8$.

A) 160

B) 150

C) 140

D) 130

8. The $E(Y/X)$ for the density function

$$f(x, y) = \begin{cases} \frac{x(1 + 3y^2)}{4}, & 0 < x < 2, \quad 0 < y < 1. \\ 0, & \text{elsewhere.} \end{cases}$$

A) $\frac{3}{4}$

B) $\frac{3}{2}$

C) $\frac{13}{4}$

D) $\frac{5}{8}$

9. Suppose that a large conference room at a certain company can be reserved for no more than 4 hours. Both long and short conferences occur quite often. In fact, it can be assumed that the length X of a conference has a uniform distribution on the interval $[0, 4]$. What is the probability that any given conference lasts at least 3 hours?

A) 1

B) $\frac{3}{4}$

C) $\frac{1}{2}$

D) $\frac{1}{4}$

10. The probability that a patient recovers from a rare blood disease is 0.4. If 15 people are known to have contracted this disease, what is the variance of the survive?

A) 1

B) 0.9

C) 1.8

D) 3.6

End of Questions

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Examiner: Prof. Dr. Mohamed Sayed Mohamed Abd Elkader & Dr. Talaat Abdelhamid

Menoufia University
Faculty of Electronic Engineering
Program: Industrial Electronics and Control
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Examiner: Dr. Emad A. Elsheikh



Final Written Exam
Course Code: ACE 352
Course Title: Elective A-1 (Introduction to Mechatronics)
No of Questions: 2
No of Pages: 3
Exam Date: 14 - 1 - 2024
Exam Time: 2 Hours

Answer the following questions:

[Total Marks: 50]

Question 1- Choose the correct answer

(18 Marks)

Note: Draw a table in your answer sheet and arrange your answer as in the following example:

x- Which valve works on electricity and not on pressure difference?

a) Rubber valve b) Pilot Valve c) Check valve d) Solenoid valve

Q No	Correct Answer
x	d) Solenoid valve

1. What is the name of the signal that is sent from the controller to an actuators in mechatronics ?

a) Noise Signal b) Error Signal c) Disturbance signal d) Control signal

2. Typically have an output, which is proportional to the variable being measured.

a) Digital sensors b) Analog sensors c) Discrete signals d) None of the above

3. It is referred to a sequence of discrete events.

a) Analog values b) Digital values c) Discrete signal d) None of the above

4. Which of the following can receive signal from the controller?

1. Motor 2. Switch 3. Gyroscope 4. Encoder 5. Lamp 6. Alarm

a) Only (1), (5), and (6) b) Only (2), (3), and (4) c) Only (1), (2), (3) and (5) d) All of the above

5. Which factor affects the least while (الأقل تأثير) selection of sensor?

a) Size b) Accuracy c) Color d) Sensitivity

6. Which component of a hydraulic system is used to store the sufficient amount of hydraulic oil?

a) Rotatory pumps b) Oil reservoir c) Flow control valve d) Pressure gauge

7. What does an Encoder do?

a) Senses mechanical motion.
b) Provides information concerning position, velocity and direction.
c) Converts analog into digital information.
d) All of the above

8. How is pressure (p) defined in terms of force(F) and area(A)?

a) $p = F \cdot A$ b) $p = F + A$ c) $p = F/A$ d) $p = F - A$

9. It is used to protect the hydraulic system against overpressure.

a) Check valve b) relief valve c) flow control valve d) None

10. It is used to determine the speed of the working fluid in the hydraulic system

a) Check valve b) relief valve c) flow control valve d) None

11. It permits flow in one direction, and prevent any flow in the opposite direction

- a) Check valve b) relief valve c) flow control valve d) None

12. It is used to control the direction of flow the hydraulic fluid to different lines in the circuit.

- a) Direction control valve b) pilot operated check valve c) flow control valve d) None

13. Suggest a type of actuator is preferable for heavy loads mechatronics application.

- a) Hydraulic b) Pneumatic c) Electric d) All of the above

14. How does a Stepper Motor move ?

- a) Continuous Applied Voltage b) Electrical Pulse c) compressed air d) PWM

15. Which mode provide smooth motion, decrease the stress of parts and increase the accuracy of the stepper motor?

- a) Full step drive mode b) Half Step Drive mode c) Micro-stepping mode

16. Is a rotating or sliding piece which used in mechanical linkage to transforming rotary motion into linear motion or vice-verse?

- a) Piston b) Cam c) idler gear d) Belt

17. Which gear is used to maintain the direction of the output shaft the same as the input shaft?

- a) Driving gear b) Driven gear c) Idler gear

18. Which of the following is(are) the disadvantages of mechatronics?

- a) Does not need of highly trained workers
b) High initial cost
c) High degree of flexibility to modify or redesign
d) Wide area of application
e) Multi-disciplinary engineering background required

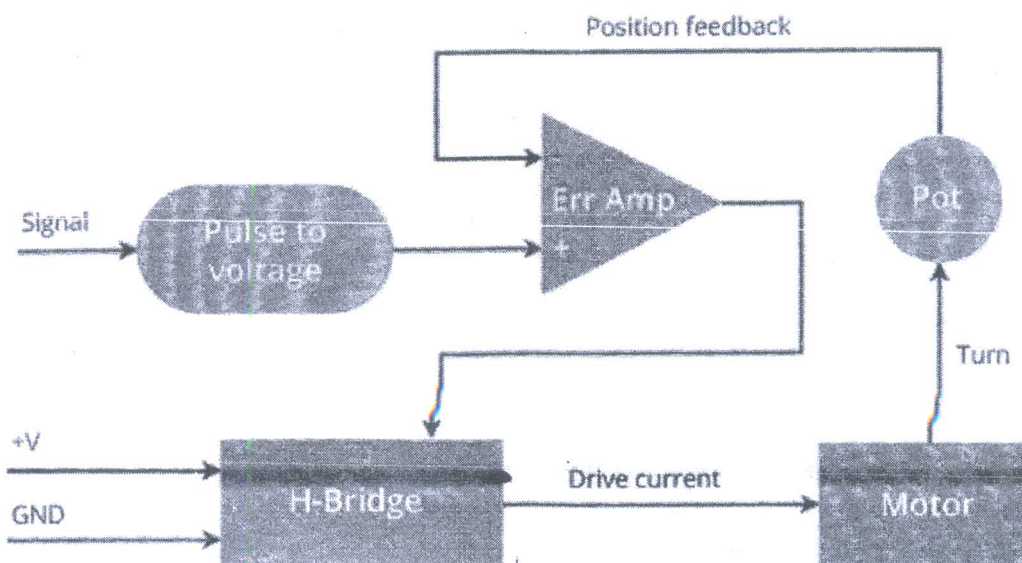
Question 2 Solve the following

(32 Marks)

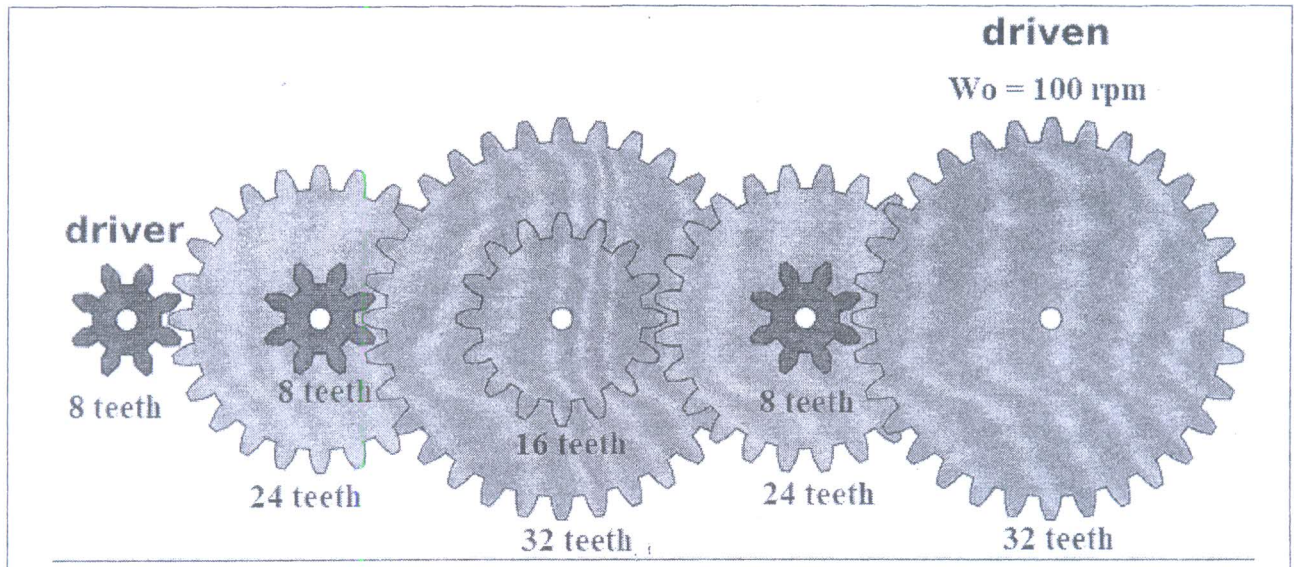
1- What are the main elements of the measurement system, sketch? (6 Marks)

2- For the following circuit shown in Figure bellow, solve the following: (6 Marks)

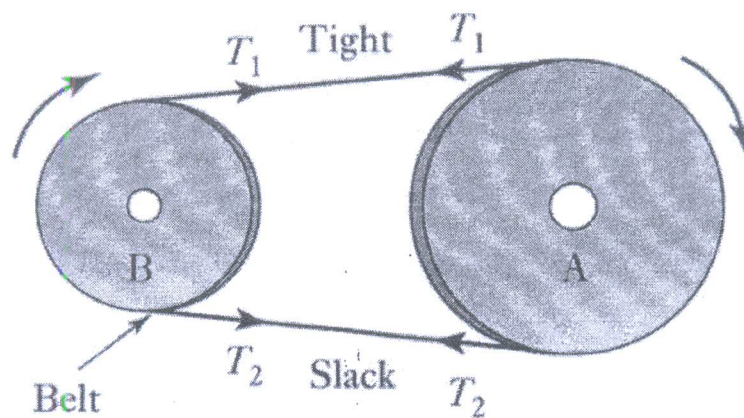
- a) What sensor is used in the circuit, and what is the main function?
b) What are the transducers used in the circuit?
c) What are the signal conditioning circuits used?



- 3- A shaft encoder is to be used with a **10 cm radius** tracking wheel to monitor linear displacement. If the encoder produces **256 pulses per revolution**, what will be the *number of pulses* produced by a linear displacement of **200 cm**? (8 Marks)
- 4- For a gear transmission system shown in the figure below, If the output speed ($\omega_o = 100 \text{ rpm}$), output torque ($T_o = 3 \text{ Nm}$), and rotate in a **clockwise direction**. Find the input shaft speed (ω_i) direction and input torque (T_i). (6 Marks)



- 5- Consider a flat belt and let T_1 and T_2 be the tensions in the belt. Find the power transmitted by a belt running over a pulley of 60 cm diameter at 200 rpm. If the tight and slack side tensions respectively are 2.5 kN and 1.244 kN. (6 Marks)



End of Questions
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