Beni Suef Technological University

Mechatronic Systems for Technologists

Syllabus

Syllabus

Course Title: Mechatronic Systems for Technologists

Course Code: N/A

Course Followers:

Students of Mechatronics Department in 2nd semester of 2nd year

Course Meeting Times

Lectures: 1 session / week, 2 hours / session

Labs: 1 session / week, 4 hours / session

Course Credits: 3

Course Introduction

The course unit deal with every element of Mechatronics which is mechanical element, electricity/electronics element and mechanisms, sensors, actuators, power electronics, interfaces and power transfer mechanisms, etc. Main contents include : Introduction to Mechatronics, Components of Mechatronics, Mechatronics Application Technology, Concept of signal conversion, A/D conversion, D/A conversion, Pneumatic/Hydraulic actuators, Electric Actuators, Interface Fundamentals, Power transmission, Mechanical mechanisms.

Course Objectives

After successfully studying this course, students will have to:

1. Familiarize to second order RLC circuits
2. Training on basic logic gates
3. Familiarize to main digital components
4. Plot Volt-Ampere Characteristics of Silicon P-N Junction Diode.
5. Find cut-in Voltage for Silicon P-N Junction diode.
6. Find static and dynamic resistances in both forward and reverse biased conditions for Si P-N Junction diode.
7. Characterize a bipolar junction transistor (BJT)
8. Characterize a metal-oxide-semiconductor field-effect-transistor (MOSFET)
9. Familiarize with amplifier circuits
10. Study OP-AMP as inverting and non-inverting amplifiers
11. Study OP-AMP as integrators and differentiators.
12. Understand the port digital input of a microprocessor.
13. Understand the principle and operation of IR and PIR sensors.
14. Implement IR sensor and PIR sensor input programs with digital input
15. Understand the port analog input of a microprocessor.
16. Understand the principles and operation of potentiometer, PSD sensor and analog temperature sensors.
17. Implement potentiometer, PSD sensor, and analog temperature sensor input programs with analog input
18. Understand how to acquire and relate data of temperature sensors
19. Understand how to operate and use real time clock
20. Understand how to operate and use EEPROM device
21. Understand the digital and analog sensor inputs of the microprocessor.
22. Through digital input, understand and program the principle and operation of various sensors.

23. Through analog input, understand and program the principle and operation of various sensors.
24. Understand the RC Servo Motor.
25. Understand PWM signal output method and related theories.
26. Learn how to operate RC Servo Motor using PWM signal.
27. Understand the analog output (PWM) of the Arduino.
28. Understand LED control program using Arduino's analog output.
29. Learn how to operate and use PWM output.
30. Actuator control by using general port and PWM.
31. Understand stepping motor.
32. Learn how to operate stepping motor using PWM signal.
33. Understand how to forward/reverse rotation of DC motor using H-Bridge circuit and I/O port.
34. Understand how to forward/reverse rotation of DC motor using H-Bridge circuit and PWM port.
35. Understand the UART communication from the microprocessor.
36. Understand the communication method and concept with Bluetooth module using UART communication.
37. Understand interface control and data collection using Bluetooth communication.
38. Understand the operating principles of hydraulic systems.
39. Identify operational characteristics, component functions, and maintenance procedures of a hydraulic system.
40. Understand the operating principles of a pneumatic system.
41. Identify operational characteristics and service procedures applicable to heavy duty compressors

Learning Outcomes

After successfully studying this course, students will be able to:

1. Familiarizing to the second order electrical circuits
2. Familiarize to main digital components
3. Plot Volt-Ampere Characteristics of Silicon P-N Junction Diode.
4. Find cut-in Voltage for Silicon P-N Junction diode.
5. Find static and dynamic resistances in both forward and reverse biased conditions for Si P-N Junction diode.
6. Design inverting and non-inverting amplifier circuit.
7. Design integrators and differentiators circuits using OP-AMP
8. Implement IR sensor and PIR sensor input programs with digital input
9. Understand how to operate and use real time clock
10. Implement potentiometer, PSD sensor, and analog temperature sensor input programs with analog input
11. Program the principle and operation of various sensors through digital input.
12. Program the principle and operation of various sensors through analog input.
13. Operate and use EEPROM device
14. Operate and use PWM output.
15. Operate stepping motor using PWM signal.
16. Master elements of Mechatronics Technology
17. Explain every function of the elements in Mechatronics system viewpoint
18. Use each element in its function appropriately and optimally for Mechatronics system design.

Prerequisites

C – Programming language

Application of Math and Science in Technology

Physics for Technicians

Electric and Electronic circuits

Textbooks

The course textbooks are:

1. APPUU KUTTAN K.K., Introduction to Mechatronics (3rd edition), Oxford University Press, 2007, India. ISBN-13: 978-0-19-568781-1
2. David G. Alciatore Michael B. Histand, Introduction to Mechatronics and Measurement Systems (4th edition), McGrawHill, 2012, USA. ISBN-13: 978-0071254076
3. Wael Z. Tawfik, Mechatronic Systems for Technologists (Practice Manual), BST, 2020.

Homework

- Homework will be issued in lectures and collected a week later in recitation.
- Corrected homework with solutions will be returned in labs the week after it is collected. You are welcome and encouraged to discuss the homework among your colleagues. However, the final formulation and write up of your homework answers must be your own.
- Submitting homework copied from someone else is a breach of ethics, and will be handled by the Committee on Discipline. More importantly, although homework counts for only 5 percent of the grade, they are critical to learning the material and to doing well on the quizzes and final exam. **One homework problem will appear in each of the tests**, and homework performance will be taken into account during grade assignment for cases that are on letter-grade boundaries.
- **Late homework will not be accepted for grading**. However, total homework grades will be based on the best nine out of eleven individual homework grades. Thus, with one exception, two homework assignments may be missed without a grading penalty.
- All homework will be graded on a coarse scale of 0 to 3 points. 3 points if all or nearly all problems are correct, 2 points if homework is approximately half correct, 1 point if mostly incorrect, and 0 points if late or not submitted.

Labs (or Tutorials/Exercise, Workshop)

- Labs will be conducted during the weeks shown in the schedule. Each lab assignment involves one or more accomplishments which must be checked off by an instructor in the lab. The instructor will be available for help and lab check-off during those weeks in which a lab is in progress.
- No written work will be due for the last lab.
- Students are welcome and encouraged to discuss the labs among your colleagues. You are also welcome to team up in pairs to execute a lab. However, the write up of your lab must be done on your own. Skipping the lab and submitting work copied from someone else is a serious breach of ethics, and will be handled by the Committee on Discipline.
- Lab assignments will be graded on a scale of 0 to 3 (3: lab complete, works, good job on pre- and post-lab; 2: lab mostly complete, reasonable job on pre and post lab; 1: lab partially done, marginal to poor job on pre- and post-lab; 0: lab not done, poor job on pre- and post-lab).

Lab Books

- You must obtain the contents of a few pages for every lab (from Lab #1 to lab #15) for recording measurements, observations and graphs of data taken during the in-lab exercises.
- Written pre-lab and post-lab exercises are also to be completed in your own papers.

Midterm Exam

- One closed-book midterm exam will be given in this term. The exam will take place few days after Lab #7 for a two-hour duration.
- There will be no lecture or lab on the day. **You may bring one two-sided sheet of notes written by your own hands to the exam**. You may also bring a calculator, eraser, pencil or ball pens.

Final Exam

- A three-hour final exam will be given during the end-of-term exam week. Timing and room assignments will be announced later. **You may bring three two-sided sheets of notes written by your own hands to the exam**.

Calendar

The calendar provides information on the course's lecture class (L), lab (Lab #), and exam (E) sessions.

SES #	TOPICS	KEY DATES
L1	Introduction to electric circuits	Homework #1 in
Lab #1	RLC Circuits	Lab report #1 in
L2	Introduction to Digital circuits	Homework #1 out Homework #2 in
Lab #2	Boolean Algebra and Basic Logic Gate Experiments	Lab report #1 out Lab report #2 in
L3	Diodes	Homework #2 out Homework #3 in
Lab #3	Junction Diode	Lab report #2 out Lab report #3 in
L4	Transistors	Homework #3 out Homework #4 in
Lab #4	Bipolar Junction Transistor Vs Field-Effect Transistors	Lab report #3 out Lab report #4 in
L5	OP-Amp	Homework #4 out Homework #5 in
Lab #5	Amplifier	Lab report #4 out Lab report #5 in
L6	Introduction to sensors	Homework #5 out Homework #6 in
Lab #6	Implementing Temperature/Humidity Sensor Firmware	Lab report #5 out Lab report #6 in
L7	Digital Input Sensor	

SES #	TOPICS	KEY DATES
Lab #7	Implementing Digital Input Sensor Control	Lab report #6 out Lab report #7 in
E1	**Midterm Exam**	
L8	Analog Input Sensor	
Lab #8	Implementing Analog Input Sensor Control	Lab report #7 out Lab report #8 in
L9	Digital / Analog Input Sensor	
Lab #9	Implementing Digital / Analog Input Sensor Control firmware	Lab report #8 out Lab report #9 in
L10	Actuators	
Lab #10	Implementing PWM Output Control Firmware	Lab report #9 out Lab report #10 in
L11	RC Servo Motor	Homework #10 out Homework #11 in
Lab #11	Implement RC Servo Motor Control Firmware	Lab report #10 out Lab report #11 in
L12	Stepping Motor	Homework #11 out Homework #12 in
Lab #12	Implement Stepping Motor Firmware	Lab report #11 out Lab report #12 in
L13	DC Motor	Homework #12 out Homework #13 in
Lab #13	Implement DC Motor Control Firmware	Lab report #12 out Lab report #13 in
E2	**Final Exam**	

Grading (or Assessment) Policy

Initial grading will be based on the following weighting:

ACTIVITIES	PERCENTAGES
Homework	5%
Labs (performance & reports)	35%
Midterm	30%
Final exam	30%

- Lab assignments will be graded on a scale of 0 to 3
  - i) 3: lab complete, works, good job on pre- and post-lab;
  - ii) 2: lab mostly complete, reasonable job on pre and post lab;
  - iii) 1: lab partially done, marginal to poor job on pre- and post-lab;
  - iv) 0: lab not done, poor job on pre- and post-lab.
- All homework will be graded on a coarse scale of 0 to 3 points,
  - i) 3 points if all or nearly all problems are correct,
  - ii) 2 points if homework is approximately half correct,
  - iii) 1 point if mostly incorrect, and
  - iv) 0 points if late or not submitted.

· This will be followed by considerable discussion among the entire teaching staff to factor in your diligence on the homework and labs, and your participation in class and labs. This discussion can affect your letter grade for the course, particularly if your initial grade is on a letter-grade boundary.

· Furthermore, failure to complete the labs in this subject will result in an overall grade that is one letter grade lower (not an Incomplete).

· This subject has been designed so that lectures, homework and labs are integral and essential parts of the learning process. Although there is no specific reward for participation, there is a clearly defined penalty for not participating. Students who consistently miss lectures, homework and labs will not be included in the grading discussions.

Lecture notes

This section contains lecture notes from some chapters of the following books,

1. APPUU KUTTAN K.K., Introduction to Mechatronics (3rd edition), Oxford University Press, 2007, India. ISBN-13: 978-0-19-568781-1
2. David G. Alciatore Michael B. Histand, Introduction to Mechatronics and Measurement Systems (4th edition), McGrawHill, 2012, USA. ISBN-13: 978-0071254076

LEC #	TOPICS	LECTURE NOTES (BOOK I FOR L1 TO L12 & BOOK II FOR L13)
L1	Introduction to electric circuits	Chapter 1: Basic Concepts (Introduction)
L2	Introduction to Digital circuits	Chapter 1: Basic Concepts
L3	Diode	Chapter 2: Electronics
L4	Transistors	Chapter 2: Electronics
L5	Op-Amp	Chapter 2: Electronics
L6	Implementing Temperature/Humidity Sensor Firmware	Chapter 3: Sensors
L7	Implementing Digital Input Sensor Control	Chapter 3: Sensors
L8	Implementing Analog Input Sensor Control	Chapter 3: Sensors
L9	Implementing Digital / Analog Input Sensor Control firmware	Chapter 3: Sensors
L10	Implementing PWM Output Control Firmware	Chapter 4: Actuators
L11	Implement RC Servo Motor Control Firmware	Chapter 4: Actuators
L12	Implement Stepping Motor Firmware	Chapter 4: Actuators
L13	Implement DC Motor Control Firmware	Chapter 4: Actuators

Lab notes (or Practice Manual)

This section contains lab notes from every chapter of the practice manual, "Wael Zakaria Tawfik, Mechatronic Systems for Technologists (Practice Manual), (Practice Manual), 2020."

LAB #	TOPICS	LAB NOTES (PRACTICE MANUAL CHAPTER)
Lab #1	RLC Circuits	Module 1 Chapter 1
Lab #2	Boolean Algebra and Basic Logic Gate Experiments	Module 1 Chapter 2
Lab #3	Junction Diode	Module 2 Chapter 1
Lab #4	Bipolar Junction Transistor Vs Field-Effect Transistors	Module 2 Chapter 2
Lab #5	Amplifier	Module 2 Chapter 3
Lab #6	Implementing Temperature/Humidity Sensor Firmware	Module 3 Chapter 1
Lab #7	Implementing Digital Input Sensor Control	Module 3 Chapter 2
Lab #8	Implementing Analog Input Sensor Control	Module 3Chapter 3
Lab #9	Implementing Digital / Analog Input Sensor Control firmware	Module 3 Chapter 4
Lab #10	Implementing PWM Output Control Firmware	Module 4 Chapter 1
Lab #11	Implement RC Servo Motor Control Firmware	Module 4 Chapter 2
Lab #12	Implement Stepping Motor Firmware	Module 4 Chapter 3