COURSE OUTLINE FOR STUDENTS AT NTU

Academic Year	2019	**Semester**	2
Course Coordinator	Associate Professor Cai Yiyu		
Course Code	MA2011		
Course Title	Mechatronics System Interfacing		
Pre-requisites	Nil		
No of AUs	3		
Contact Hours	Lectures: 26 hours Tutorials: 13 hours		
Proposal Date	November 2019		

Course Aims

This course aims to provide you with the fundamental concept of measurement and treatment of experimental data. Data time dependent characteristics, instrumentation for measurement of physical variables, detection circuits, signal conditioning, data acquisition and electromechanical actuators will be covered so that you can use them in manufacturing and automated production.

Intended Learning Outcomes (ILO)

Upon successful completion of the course, you will be able to:

1) Explain the various types of measurement equipment and their basic operating characteristics.
2) Select appropriate measuring equipment for different kinds of applications.
3) Describe the basic relationships between time and frequency domain of signals.
4) Integrate sensors and electromechanical actuators based on the fundamental requirements of mechatronic systems.

Course Content

	Topic	Hours
1.	**Measurement System Behaviour** Models and classification for measurement systems and their time and frequency domain behaviours. Performance specifications.	4
2.	**Analog Devices and Measurement** Introduction to basic measurement devices for analog signals and measurement principles. Conditioning of analog signals for transmission and processing.	5
3.	**Digital Devices and Measurement** Fundamental differences between analog and digital systems. Sampling theorem and fundamentals of data acquisition.	4

4.	**Sensors** Measurement for common engineering applications: position, speed, stress, strain, temperature, vibration and acceleration, pressure and flow. Semiconductor sensors and micromechanical devices.	6
5.	**Actuators** Electromagnetic principles, solenoid relays. Electric motors, dc motors, permanent magnet dc motor, stepper motors and motor selection. Hydraulic and pneumatic actuators.	5
6.	**Drives for Motion Control** Pulse width modulation, switching transistors and three-phase drive system. Electronic control of permanent magnet and stepper motors. Examples of Matlab programming and case studies of robotic applications with relevance to Industry 4.0	2

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/ Individual	Assessment rubrics
1. Continuous Assessment1 – Team Project Presentation	LO1-3	*EAB SLO a, b, d, i*	20%	Team	Appendix 1
2. Continuous Assessment2 – Quiz 2	LO4	*EAB SLO a, b, d*	20%	Individual	
3. Final Examination – Restricted Open Book; 2.5hrs	LO1-4	*EAB SLO a, b, c, d, e*	60%	Individual	
Total			100%		

Formative feedback

• The outcome of the quiz will be released through NTULearn (on grades) and discussed after the quiz to provide feedback and correct any mistakes/misapplication of concepts made by you.

• You are encouraged to participate actively in tutorial class for hands-on. This will help clarify your doubts.

• Feedback will be welcome through the course, where you could write in to the lecturers for constructive suggestions.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lecture	All concepts, involved in the course, are explained; examples of practical problems solving are provided. While theoretical concepts are explained the pre-recorded lectures, during live-lectures you are exposed to problem solving via CAS (Computer Algebra Systems).
Tutorial	You are to learn how to employ the concepts you learned for solving problems individually and discuss the solutions presented during the tutorial sessions

Reading and References

Textbook

1. Introduction to Mechatronics and Measurement Systems, 3rd edition, Alciatore,D.G., Histand,M.B., McGraw-Hill, 2007.

References

1. Maloney, TJ, Modern Industrial Electronics, 4th Edition, Prentice Hall, 2001.
2. Figliola, RS and Beasley, DE, Theory and Design for Mechanical Measurements, 4th Edition, John Wiley & Sons, 2006.
3. Doebelin, EO, Measurement Systems: Application and Design, 4th Edition, McGraw-Hill, 1990.
4. Dally, JW, Instrumentation for Engineering Measurements, 2nd Edition, John Wiley, 1993.

Course Policies and Student Responsibilities

As a student of the course, you are required to abide by both the University Code of Conduct and the Student Code of Conduct. The Codes provide information on the responsibilities of all NTU students, as well as examples of misconduct and details about how students can report suspected misconduct.

The university also has the Student Mental Health Policy. The Policy states the University's commitment to providing a supportive environment for the holistic development of students, including the improvement of mental health and wellbeing. These policies and codes concerning students can be found in the following link.
http://www.ntu.edu.sg/SAO/Pages/Policies-concerning-students.aspx

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Cai Yiyu	N3.2-01-08	6790 5777	MYYCAI@ntu.edu.sg
Domenico Campolo	N3.2-02-74	6790 5610	D.CAMPOLO@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Part 1. Introduction 1.1 Measurement Systems 1.2 Amplitude Linearity 1.3 Fourier Series Representation of Signals 1.4 Bandwidth and Frequency Response	LO1 & 3	Access Recorded Video NTULearn/ LAMS
2	Part 2. Fourier Series Method 1.5 The Periodic Functions 1.6 Fourier Series Decomposition 1.7 The Complex Forms of Fourier Series Representation 1.8 Insights of Fourier Series Method	LO3	Access Recorded Video NTULearn/ LAMS Tutorial #1
3	Part 3. Dynamic System Response 3.1 Physical Systems & Dynamics Characteristic 3.2 Ordinary Differential Equations for Dynamics Measurement Systems 3.3 Zero-Order Systems 3.4 First-Order Systems 3.5 Second-Order System 3.6 System Modelling and Analogies	LO3	Access Recorded Video NTULearn/ LAMS Tutorial #2
4	Part 4, Sampling 4.1 Background & Objectives 4.2 Shannon & Nyquist Theorem 4.3 Aliasing 4.4 Applications 4.5 Quantising & Coding	LO3	Access Recorded Video NTULearn/ LAMS Tutorial #3
5	Part 5. Analog Signal Processing using Operational Amplifiers 5.1 Background	LO2	Access Recorded Video

	5.2 Amplifiers 5.3 Operational Amplifiers 5.4 Deal Model for Operational Amplifiers 5.5 Inverting Amplifier 5.6 Noninverting Amplifier 5.7 Summer Amplifier 5.8 Difference Amplifier 5.9 Integrator 5.10 Differentiator 5.11 Sample and Hold Circuit 5.12 Comparator 5.13 Instrumentation Amplifier		NTULearn/ LAMS Tutorial #4
6	Part 6. A/D Conversion 6.1 Data Acquisition Devices 6.2 A/D Conversion 6.3 A/D Converters Part 7. D/A Conversion 7.1 Background 7.2 D/A Conversions	LO2 & 3	Access Recorded Video NTULearn/ LAMS Tutorial #5
7	Team Project Presentation		Presentation
8	Intro to sensors and measurements	LO4	Pre-recorded lectures Live demonstration
9	Examples of sensing devices and measurement systems	LO4	Pre-recorded lectures Live demonstration
10	Strain Gauges and Force Sensors	LO4	Pre-recorded lectures Live demonstration
11	Intro to actuation principles	LO4	Pre-recorded lectures Live demonstration
12	DC motors working principles	LO4	Pre-recorded lectures Live demonstration /Lab visit
13	DC motors control techniques and examples applications to Robotics	LO4	Pre-recorded lectures Live demonstration / lab visit