Liverpool John Moores University

Title:	Digital and Analogue Electronics
Status:	Definitive
Code:	**4304CIT** (125297)
Version Start Date:	01-08-2020
Owning School/Faculty:	Engineering
Teaching School/Faculty:	Changshu Institute of Technology

Team	Leader
Wei Zhang	Y
Obrad Dordevic	

Academic Level:	FHEQ4	**Credit Value:**	20	**Total Delivered Hours:**	82
Total Learning Hours:	200	**Private Study:**	118		

Delivery Options
Course typically offered: Semester 2

Component	Contact Hours
Lecture	64
Practical	16

Grading Basis: 40 %

Assessment Details

Category	Short Description	Description	Weighting (%)	Exam Duration
Exam	Exam	Exam	60	2
Practice	Experiment	Experiment	30	
Report	Coursework	Coursework	10	

Aims

The Students completing this course will understand basic analog and digital electronics, including semiconductor properties, operational amplifiers, combinational and sequential logic and analog-to-digital digital-to-analog conversion techniques. Finally, students will gain experience in with the design of analog amplifiers, power supplies and logic devices.

Learning Outcomes

After completing the module the student should be able to:

1	Explain the characteristics of basic analogue electronic circuit elements, including diodes and transistors.
2	Develop and design basic analogue electronic circuits and systems
3	Explain the characteristics of basic digital electronic circuit elements, including gates and flip flops.
4	Explain and solve arithmetic problems using a variety of digital number representations, including unsigned and signed binary, BCD, octal, decimal and hexidecimal.
5	Develop and design combinatorial and sequential digital electronic circuits and systems, including adders and mixed analogue/digital circuits, through the use of DACs and ADCs with a micro-controller.
6	Build and debug digital and analog electronic circuits and systems in a laboratory or assignment setting, communicating and working with student peers, demonstrators and technical staff, and documenting experimental outcomes.

Learning Outcomes of Assessments

The assessment item list is assessed via the learning outcomes listed:

Exam	1	2	3	4	5
Experiment	2	3	4	5	6
Coursework	2	3	4	5	6

Outline Syllabus

1. SEMICONDUCTORS DEVICES.
Solid State Physics. Mobility. Electrons and holes. The P-N junction. Diodes. Zener effect. Zener effect diode. Avalanche effect. Avalanche effect diode. Bipolar Transistors.
PNP and NPN junctions. Base, collector and emitter.H parameters equivalent circuit. Common emitter amplifier. DC behaviour: the load slope and the Q point. AC behaviour. Emitter follower amplifier. Field effect transistors: JFET and MOSFET. Source, Drain and Gate.
2. OPERATIONAL AMPLIFIERS: DC PERFORMANCE.
The operational amplifier. Input resistance. Output resistance. Open loop gain. Bias currents. Offset currents. Offset voltage. Differential mode gain. Common mode gain. Common mode rejection ratio. Negative feedback. Open loop gain and closed loop gain. Inverter amplifier. Addition amplifier. Non-inverter amplifier. The voltage follower. Transimpedance amplifier (Current to voltage converter). Howland pump. Differential amplifier.
3. OPERATIONAL AMPLIFIERS: AC AND TRANSIENT PERFORMANCE.
Frequency response. Bode Plot. Stability. Barkhausen's criteria. Phase margin and amplitude margin. Differentiator amplifier. Integrator amplifier. Logarithmic amplifier.

Transient response.
4. POWER SUPPLIES
Rectification. Half wave and completed wave. Filters. Ripple band. Linear regulator. The 78XX and 79XX family. Switching regulators.
5. DIGITAL TECHNIQUES: PRINCIPLES.
Numbering systems. Binary, octal and hexadecimal numbers. Boole algebra. Conversion and operations. AND gate. OR gate. Inverter. NAND gate. NOR gate. Exclusive OR gate. Morgan's laws. Logic families. TTL and CMOS.
6. DIGITAL TECHNIQUES: COMBINATIONAL CIRCUITS.
Truth tables. Karnough's diagram. Miniterm addition. Maxiterm product. Synthesis of combinational circuits. Logic comparators. Codifiers. Decodifiers. Multiplexers.
7. DIGITAL TECHNIQUES: SEQUENCIAL CIRCUITS.
Monostable oscillator. Bistable oscilador. Astable oscilador. The MC555. The "Flip-Flop". Flip Flop (FF) types: RS type. JK FF. JK FF Master slave. D FF. T FF. Level detector and slope detector. Counters. Shift registers.
8. DIGITAL TO ANALOG CONVERTERS and ANALOG TO DIGITAL CONVERTERS.
Input latch. Binary Weighted Resistor Network. R-2R Ladder Resistor Network. Pulse Width Modulation . Resolution. Accuracy. Linearity. Zero Offset. Settling Time. Glitches.
Sampling. Real time sampling and equivalent time sampling. Sampling frequency. Sampling theorem (Nyquist). Anti–aliasing filtering. Sampling and holding. Conversion. Quantification.
Integrative Analog to Digital (A/D) conversion. The linear counting method. The successive approximation method.

Learning Activities

A combination of lectures and practical work.

Notes

Indicative Content and Learning Activities
Digital Arithmetic
Alternate number bases: binary, octal, hexadecimal. Base conversion. Binary arithmetic. Signed number representation. Logic circuits for addition and substraction.

Combinatorial Logic
Basic Boolean operators (AND, OR, NOT) and corresponding ciruit elements. Boolean algebra. De Morgan's Laws. Further Boolean operators (XOR, NAND, NOR). Minimisation of logic functions using Boolean algebra and using Karnaugh maps, including 3-variable and 4-variable cases.

Diode devices
Semiconductor materials and properties. Forward/reverse bias pn junctions. Diode equation. Reverse breakdown and zener diodes.

Transistor devices
Introduction to Bipolar Junction Transistors (BJT) and Field Effect Transistors (FET): MOSFET, JFET. FET.

Sequential Logic
Sequential logic elements including S-R, D, and J-K latches and flip-flops. Basic applications of flip-flops, including registers and counters.

Analogue & Digital
Introduction to the concepts of digital-to-analogue and analogue-to-digital conversion. This material also introduces the Arduino micro-controller and applies it to the task of A2D and D2A (PWM) conversion. The students perform an investigative laboratory on this topic.