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DIGITAL ELECTRONICS AND MICROCONTROLLER APPLICATIONS **Course Code : 314324**

Programme Name/s : **Electrical Engineering/ Electrical Power System**

Programme Code : **EE/ EP**

Semester : **Fourth**

Course Title : **DIGITAL ELECTRONICS AND MICROCONTROLLER APPLICATIONS**

Course Code : **314324**

I. RATIONALE

In the era of digitization, all the equipment like computers, mobiles, music systems, ATM, automation and control circuits and systems are built on digital circuits. Diploma Electrical pass out plays a key role in control panel operations based on microcontroller systems. This course emphasizes on knowledge of digital electronics required to use microcontroller-based systems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

• Use microcontroller based systems for various industrial applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply knowledge of number system and logic circuits in working of digital system.
- CO2 - Build simple combinational and sequential circuits.
- CO3 - Access various registers in 8051 microcontroller.
- CO4 - Develop and execute programs in assembly language for microcontroller.
- CO5 - Use microcontroller in various applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314324	DIGITAL ELECTRONICS AND MICROCONTROLLER APPLICATIONS	DEM	SEC	3	-	4	1	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

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Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Recognize and convert the given number into the specified number system. TLO 1.2 Perform the binary and BCD arithmetic operation on the given numbers. TLO 1.3 Develop the basic gates using the given NAND/NOR gate as universal gate. TLO 1.4 Construct adder and subtractor circuit using logic gates.	**Unit - I Number System and Logic Gates** 1.1 Number System : Decimal, Binary, octal, hexadecimal, BCD. Conversion of one system into other. 1.2 Binary Arithmetic: - Addition, Subtraction (1's and 2's complement) Multiplication, Division. BCD addition. 1.3 Logic Gates: Symbol, switch circuit, logical expression, truth table of basic logic gates (AND, OR, NOT), Universal gates (NAND and NOR) and Special purpose gates (EX-OR, EX-NOR). 1.4 Arithmetic Circuits: Half and full Adder, Half and full subtractor with its truth table, boolean expression and circuits using logic gates.	Chalk-Board Presentations Demonstration Flipped Classroom
2	TLO 2.1 Draw MUX/DEMUX tree for the given number of input and output lines. TLO 2.2 Describe the building process of the specified type of flip-flop. TLO 2.3 Use excitation table of the given flip-flop to design asynchronous counter.	**Unit - II Digital Logic Circuits** 2.1 Multiplexer and Demultiplexer: working , truth table and applications of Multiplexers and Demultiplexers. 2.2 SR Flip Flops: SR-flip flop, clocked SR flip flop with preset and clear, drawbacks of SR flip flop. JK Flip Flops: Clocked JK Flip flop with preset and clear, D and T type flip flop, Excitation table of flip flops. 2.3 Counters: Types (Asynchronous, Synchronous) and their applications.,4 bit asynchronous counter – Circuit diagram and truth table.	Chalk-Board Presentations Video Demonstrations Flipped Classroom

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Compare the salient features of microcontroller and microcomputer for the given parameters. TLO 3.2 Compare the given types of architecture on the given parameters. TLO 3.3 Describe the given types of registers of 8051. TLO 3.4 Justify the use of the given type of memory in 8051.	**Unit - III 8051 Microcontroller Architecture** 3.1 Microcomputers and microcontrollers (basic introduction and comparison). 3.2 Types of buses, address bus, data bus and control bus. Harvard and Von-Neumann architecture. 3.3 8051 Microcontroller Architecture: - Pin configuration, Register banks, bit and byte addressable area, Registers: PC, DPTR, A&B, PSW and other Special function registers(SFR), I/O ports, Timers (pins and associated SFRs). 3.4 Stack and stack pointer , memory organization (RAM , ROM).	Chalk-Board Presentations Video Demonstrations Flipped Classroom
4	TLO 4.1 Identify addressing mode of the given instruction with examples. TLO 4.2 Describe function of the given instruction with suitable examples. TLO 4.3 Justify the use of the given assembler directives with examples.	**Unit - IV 8051 Instruction Set and Programming** 4.1 Addressing Modes: Immediate, register, direct, indirect, indexed, relative, absolute, bit inherent, bit direct. 4.2 Instruction Set (with appropriate example) : Data transfer, Logical, Arithmetic, Branching, Machine control, Stack operation, Boolean. 4.3 Assembler Directives: ORG, DB, EQU, END, CODE, DATA .	Chalk-Board Presentations Video Demonstrations Flipped Classroom Hands-on
5	TLO 5.1 Describe with sketches the procedure to interface the given external memory. TLO 5.2 Describe with sketch the interfacing of the given external I/O devices.	**Unit - V 8051 Interfacing and Application** 5.1 Memory interfacing - Program and Data memory 5.2 I/O Interfacing (Diagram and Flowchart) for following applications - LED, Relays, Switch, LCD, Stepper motor.	Lecture Using Chalk-Board Presentations Demonstration Flipped Classroom Hands-on

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Build AND, OR, NOT gates to verify its truth table.	1	* Verification of truth table of AND, OR, NOT gates using ICs .	2	CO1
LLO 2.1 Build AND, OR, NOT gates using NAND gate and verify its truth table of NAND gate as universal gate	2	Building of AND, OR, NOT gates using NAND gate.	2	CO1
LLO 3.1 Build AND, OR, NOT gates using NOR gate and verify NOR gate as universal gate.	3	* Building of AND, OR, NOT gates using NOR gate.	2	CO1
LLO 4.1 Build Half adder and Half subtractor.	4	* Building of Half adder and Half subtractor using Boolean expressions.	2	CO1
LLO 5.1 Build Full adder and full subtractor.	5	* Building of Full adder and full subtractor using Boolean expressions.	2	CO1
LLO 6.1 Build a Multiplexer using IC.	6	* Verification of operation of Multiplexer IC 74151	2	CO2
LLO 7.1 Build a Demultiplexer using IC.	7	Verification of operation of Demultiplexer IC 74155	2	CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Test the function of RS flip flop.	8	Testing the function of RS flip flop using NAND Gate.	2	CO2
LLO 9.1 Test the function of JK flip flop.	9	Testing the function of JK flip flop using 7476.	2	CO2
LLO 10.1 Construct and test the functionality of D flip flop.	10	* Construction and testing the functionality of D flip flop using IC 7476.	2	CO2
LLO 11.1 Construct and test the functionality of T flip flop.	11	* Construction and testing the functionality of T flip flop using IC 7476.	2	CO2
LLO 12.1 Implement 4 bit ripple counter using 7476.	12	Implementation of 4 bit ripple counter using 7476.	2	CO2
LLO 13.1 Develop and execute an assembly language program (ALP) to perform addition of 8-bit data .	13	* Assembly language program (ALP) to perform addition of 8-bit data using various addressing modes.	2	CO3 CO4
LLO 14.1 Develop and execute an assembly language program (ALP) to perform subtraction of 8-bit data.	14	* Assembly language program (ALP) to perform subtraction of 8-bit data using addressing modes.	2	CO3 CO4
LLO 15.1 Develop and execute an assembly language program (ALP) to perform multiplication of 8-bit data.	15	*Assembly language program (ALP) to perform multiplication of 8-bit data , take the input data from port1 and display the output data on port 2	2	CO3 CO4
LLO 16.1 Develop and execute an assembly language program (ALP) to perform division of 8-bit data	16	* Assembly language program (ALP) to perform division of 8-bit data , take the input data from port 2 & display the output data on port 0	2	CO3 CO4
LLO 17.1 Develop and execute an assembly language program to transfer data using internal data memory.	17	* Assembly language program to transfer data from source to destination location of internal data memory.	2	CO3 CO4
LLO 18.1 Develop and execute an assembly language program to transfer data using external data memory.	18	Assembly language program to transfer data from source to destination location of external data memory.	2	CO3 CO4
LLO 19.1 Develop and execute an assembly language program to exchange data of memory locations.	19	* Assembly language program to exchange data from source to destination memory location.	2	CO3 CO4
LLO 20.1 Develop and execute an assembly language programto find smallest number from the given data.	20	Assembly language program to find smallest number from the given data bytes stored in internal / external data memory locations.	2	CO3 CO4
LLO 21.1 Develop and execute an assembly language program to find largest number from the given data.	21	* Assembly language program to find largest number from the given data bytes stored in internal / external data memory locations.	2	CO3 CO4
LLO 22.1 Develop and execute an assembly language program for arranging numbers in ascending order.	22	* Assembly language program for arranging numbers in ascending order stored in external memory locations.	2	CO3 CO4
LLO 23.1 Develop and execute an assembly language program for arranging numbers in descending order.	23	Assembly language program for arranging numbers in descending order stored in external memory locations.	2	CO3 CO4

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 24.1 Develop and execute an assembly language program for masking particular bit of given register. LLO 24.2 Develop and execute an assembly language program to SET particular bit of given register.	24	* Assembly language program MASK and SET particular bit of given register using 1) bit addressable instructions 2) Logical instructions.	2	CO3 CO4
LLO 25.1 Develop and execute an assembly language program to get a rolling display on given I/O port.	25	* Assembly language program to get a rolling display on port 2.	2	CO3 CO4
LLO 26.1 Interface LED with 8051. LLO 26.2 Interface SWITCH with 8051.	26	* Interfacing of LED and switch with 8051 to turn ON / OFF the LED.	4	CO5
LLO 27.1 Interface RELAY with 8051.	27	* Interfacing of RELAY with 8051 to turn ON / OFF the LED.	2	CO5
LLO 28.1 Interface 7-segment display with 8051.	28	Interfacing of 7-segment display with 8051 to give output as decimal number from 0 to 9.	2	CO5
LLO 29.1 Interface 7-segment display with 8051.	29	Interfacing of LCD with 8051 microcontroller to display the alphabets and decimal numbers.	2	CO5
LLO 30.1 Interface 7-segment display with 8051.	30	Interfacing of stepper motor with 8051 microcontroller and write ALP to rotate stepper motor in clockwise and anti-clockwise direction at given angles.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Following are the suggested student-related co-curricular activities

- Prepare a chart of various logic gates & their truth table.
- Prepare power point presentation on digital circuit microcontroller applications.
- Give seminar on relevant topic.
- Undertake a market survey of different microcontroller ICs and collect information regarding- Nnumber of pins, number of bit, clock frequency of operation etc.

Micro project

- Build a circuit of ALU using IC 74181.
- Build a circuit for decade counter using IC 7490.
- Build a water level controller to indicate overflow & under level of water in a tank.
- Build a dc motor speed controller using 8051.
- Prepare a chart of various features using data sheets of 8051 microcontroller and its derivatives.
- Build a circuit to turn the buzzer ON after 10 seconds.

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Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Digital Multimeter: 3 and ½ digit with R, V, I measurements, diode and BJT testing.	1,2,3,4,5,6,7,8,9,10,11,12
2	DIGITAL IC tester: Provision for testing a wide range of Digital IC's such as 74 Series, 40/45 Series of CMOS IC’s.	1,2,3,4,5,6,7,8,9,10,11,12
3	Bread Board Development System: Bread Board system with DC power output 5V, +/-12V and 0-5V variable , digital voltmeter , ammeter, LED indicators 8 no, logic input switches 8 no, 7 segment display 2 no, clock generator, Manual pulser, Breadboard with about 1,600 points, Potentiometer, relay etc	1,2,3,4,5,6,7,8,9,10,11,12
4	Trainer kits for digital ICs: Trainer kit shall consists of digital ICs for logic gates, flop-flop, shift registers, counter along with toggle switches for inputs and bi-colour LED at outputs, built in power supply.	1,2,3,4,5,6,7,8,9,10,11,12
5	Regulated power supply: Floating DC Supply Voltages Dual DC : 2 x 0 -30V; 0-2 A Automatic Overload (Current Protection) Constant Voltage and Constant Current Operation Digital Display for Voltage and Current Adjustable Current Limiter Excellent Line and Load Regulation	1,2,3,4,5,6,7,8,9,10,11,12
6	Latest Desktop PC compatible with microcontroller IDE simulation software	13,14,15,16,16,17,18,19,20,21,22,23,24,25,26,27,28,29,3
7	Microcontroller kit :-single board systems with 8K RAM,ROM memory with battery back up,16X4,16 X2, LCD display, PC keyboard interfacing facility, Hex keypad facility, single user cross c-compiler,RS-232,USB, interfacing facility with built in power supply.	26,27,28,29,30
8	Relay with driver ,5V	27
9	LCD trainer board	29
10	Stepper Motor, 50/100 RPM with driver circuitry	30

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IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Number System and Logic Gates	CO1	8	6	6	4	16
2	II	Digital Logic Circuits	CO2	12	2	4	8	14
3	III	8051 Microcontroller Architecture	CO3	12	6	6	4	16
4	IV	8051 Instruction Set and Programming	CO4	8	2	6	4	12
5	V	8051 Interfacing and Application	CO5	5	2	2	8	12
Grand Total				**45**	**18**	**24**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Each practical will be assessed considering : 60 % weightage to process. 40 % weightage to product
- Average of Two unit tests of 30 marks each will be considered.
- Laboratory learning will be of 25 marks.

Summative Assessment (Assessment of Learning)

- End of Term Examination (Lab. performance), Viva-voce

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	1	2	-	-	1			
CO2	3	-	2	2	-	1	1			
CO3	3	-	-	1	-	2	1			
CO4	3	3	3	2	1	2	2			
CO5	3	3	3	2	1	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	R.P. Jain	Modern Digital Electronics	McGraw-Hill Publishing, New Delhi, 2009; ISBN: 9780070669116

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Sr.No	Author	Title	Publisher with ISBN Number
2	V.K.Puri	Digital Electronics	McGraw Hill Education (1 July 2017); ISBN-13 : 978-0074633175
3	Salivahanan S.; Arivazhagan S.	Digital Circuits and Design	Oxford University Press India; 5th edition ; ISBN13- 978-0199488681
4	Malvino, A.P.; Leach, D.P.; Saha G.	Digital Principles and Applications	McGraw Hill Education, New Delhi, 2014, ISBN : 9789339203405
5	V. Udayashankara M. S. Mallikarjuna Swamy	8051 Microcontroller: Hardware, Software and application.	McGraw Hill Education; 1st edition; ISBN-13 : 978-0070086814
6	Kenneth Ayala	8051 Microcontroller Architecture Programming and Application	Cengage Learning India; 3rd edition ; ISBN-13 : 978-8131502006
7	Mazidi, Mohmad Ali; Mazidi, Janice Gelispe; Mckinlay Roline D.	The 8051 Microcontroller and Embedded system	Pearson Education India; 2nd edition; ISBN-13 : 978-0199681273
8	Ajay Deshmukh	Microcontroller Theory and Application	Mc Graw Hill., New Delhi,2011, ISBN- 9780070585959

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.keil.com/download/	Simulation software
2	https://archive.nptel.ac.in/courses/108/105/108105102/	NPTEL course on-Microprocessors and Microcontrollrs
3	https://nptel.ac.in/courses/117104072	NPTEL Course-Microcontrollers and Applications, IIT Kanpur by Dr. S.P. Das
4	https://play.google.com/store/apps/details?id=com.coderbro.tutorial.a8051microcontroller&hl=en_IE	Android App for Microcontroller 8051

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 21/11/2024 **Semester - 4, K Scheme**