DR.BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,

CHHATRAPATI SAMBHAJINAGAR.

NAAC- 'A+' Grade

CIRCULAR NO.SS/ Sci & Tech./ B.Voc /14 /2025.

It is hereby inform to all concerned that, on recommendation of the Dean, Faculty of Science & Technology **Academic Council at its meeting held on 21 July, 2025 has been accepted the revised syllabi of following *Curriculum at UG Level* as per National Education Policy-2020" *1. B.Voc in Industrial Automation, 2. Automobile Division,*** (revised) ***of under*** **the Faculty of Science & Technology run at the Department, Deen Dayal Upadhyay Kaushal Kendra, Dr. Babasaheb Ambedkar Marathwada University as appended herewith.**

This is effective from the Academic Year 2025-26 onwards under the Faculty of Science & Technology.

All concerned are requested to note the contents of the circular and bring notice to the students, teachers and staff for their information and necessary action.

University campus,
Chhatrapati Sambhajinagar-431004.
Ref. No. S S/Sci & Tech/B.Voc./2025-26/
Date: 01/ 08/ 2025 1436-38

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Deputy Registrar,
Syllabus Section

Copy forwarded and Information to necessary action:-

1] **The Director, Department, of, Deen Dayal Upadhyay Kaushal Kendra, Dr. Babasaheb Ambedkar Marathwada University.**

2] **The Director, Board of Examination & Evaluation,**

3] **The Director,** University Network & Information Centre, UNIC, with a **request to upload this circular on University Website.**
Dr. Babasaheb Ambedkar Marathwada University **Chhatrapati Sambhajinagar.**

Dr. Babasaheb Ambedkar Marathwada University

Chhatrapati Sambhajinagar- 431001

Deen Dayal Upadhyay KAUSHAL Kendra

Three Year
B.VOC. Degree Program

Course Structure Sem III- IV & Syllabus Sem III

(Revised)

(AS PER NEP-2020)

Subject (Major): INDUSTRIAL AUTOMATION

(Pattern 2024)

Effective from 2025-26

1/7/2025

Course Structure for Semester – III & IV

B.VOC Industrial Automation

Course Structure for Semester III of Bachelor of Vocation Major (Industrial Automation)							
Course Type	Course Code	Course Name	Teaching Scheme (Hrs / Week)		Credits Assigned		Total Credits
			Theory	Lab Course	Theory	Lab Course	
Major (Core) M7 Mandatory	IA/DSC/T/200	Embedded Systems	2		2		2+2=4
	IA /DSC/P/226	Embedded Systems Lab		4		2	
Major (Core) M8 Mandatory	IA/DSC/T/201	Process Control	2		2		2+2=4
	IA /DSC/P/227	Process Control Lab		4		2	
Minor Course **It is from Different Discipline from same faculty**	**To be chosen from Other Discipline of same faculty**		2		2		2+2=4
			2		2		
Generic / Open Elective (GE/OE) (Choose any one from pool of courses) **It should be chosen compulsorily from the faculty other than that of Major**	**It should be chosen compulsorily from the faculty other than that of Major**		2		2		2
VSC (Vocational Skill Courses) (Choose any one from pool of courses)	IA / VSC/T/200	Industrial AC Motors	1		1		1+1=2
	IA / VSC /T/201	Variable Frequency Drives	1		1		
	IA / VSC /P/226	Industrial AC Motors Lab		2		1	
	IA / VSC /P/227	Variable Frequency Drives Lab		2		1	
AEC, VEC, IKS	IA /AEC/T/200	English- 2 (Common for all the faculty)	2		2		2+2 =4
	IA /VEC/T/201	Environmental Studies	2		2		
OJT/ FP/CEP/CC/RP	IA/CC/P/226	Cultural Activity/ NSS, NCC (Common for all Faculty)		4		2	2
							22

Minor Courses for Other Discipline offered by DDUKK (Industrial Automation): (2 Credits Each)
1) IA/MN/T/200 : Semiconductor Devices 2) IA/MN/T/201: Basic Industrial Measurements
Generic / Open Elective offered for Other Faculty by DDUKK (Industrial Automation): (2 Credits)
IA/GE/OE/T/200: Embedded System

Course Structure for Semester IV of Bachelor of Vocation Major (Industrial Automation)							
Course Type	Course Code	Course Name	Teaching Scheme (Hrs / Week)		Credits Assigned		Total Credits
			Theory	Lab Course	Theory	Lab Course	
Major (Core) M9 Mandatory	IA/DSC/T/250	Fundamentals of Flexible Manufacturing Systems	2		2		2+2=4
	IA /DSC/P/276	Fundamentals of Flexible Manufacturing Systems Lab		4		2	
Major (Core) M10 Mandatory	IA/DSC/T/251	Fundamental of Industrial Robotics	2		2		2+2=4
	IA /DSC/P/277	Fundamental of Industrial Robotics		4		2	
Minor Course **It is from Different Discipline from same faculty**	**To be chosen from Other Discipline of same faculty**		2		2		2+2=4
			2		2		
Generic / Open Elective (GE/OE) (Choose any one from pool of courses) **It should be chosen compulsorily from the faculty other than that of Major**	**It should be chosen compulsorily from the faculty other than that of Major**		2		2		2
SEC (Skill Enhancement Courses) (Choose any one from pool of courses)	IA /SEC/T/250	IOT	1		1		1+1= 2
	IA /SEC/T/251	SCADA	1		1		
	IA /SEC/P/276	IOT Lab		2		1	
	IA /SEC/P/277	SCADA LAB		2		1	
AEC, VEC, IKS	IA /AEC/T/250	Modern Indian Language (MIL – 2)	2		2		2+2 =4
	IA /FP/P/276	Field Project	2		2		
OJT/ FP/CEP/CC/RP	IA/CC/P/277	(Fine/ Applied/ Visual/ Performing Arts)				2	2
							22

Minor Courses for Other Discipline offered by DDUKK (Industrial Automation): (2 Credits Each)
1) IA/MN/T/250 : Applied Fluidics 2) IA/MN/T/251: Discrete State Process Control
Generic / Open Elective offered for Other Faculty by DDUKK (Industrial Automation): (2 Credits)
IA/GE/OE/T/250: Fundamental of Industrial Robotics

Syllabus for Semester – III

B.VOC Industrial Automation

Major (Core)
Mandatory

IA/DSC/T/200: Embedded Systems

Total Credits : 02

Total Contact Hours : 30 Hrs Maximum Marks : 50

Learning Objectives of the Course:

1. To provide students foundational knowledge of Embedded C Programming
2. To Provide students with functional knowledge with Arduino Uno
3. To provide students with basic idea of prototyping

Course Outcomes (COs) :

On completion of the course, students should be able to -

1. Apply concepts to embedded C to develop programs in Arduino IDE
2. Develop prototypes with Arduino UNO

CO-PO-PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	H								H	H	H	H
CO2	H	H	H	H	H								H	H	H	H
CO3	H	H	H	H	H								H	H	H	H

Module No.	Course Content	Contact Hours
I	**Introduction to Arduino and Programming Environment** Introduction - What is Arduino, Introduction to Arduino family, Arduino Shields; Creating an Arduino Programming Environment – Exploring microcontroller Internals, Moving beyond machine codes, Creating Arduino programs, Installing the Arduino IDE, Overview of Arduino IDE, Exploring IDE – Menus, Toolbar, Message Area and Console Window, Setting Up Arduino IDE, Using Serial Monitor; Building a Basic Arduino sketch, Interfacing Concept with Electronic Circuits	10 Hrs
II	**Hydraulic Elements in Design of Circuits - I** Basics of C - Working with variables, Operators, Exploring Arduino functions; Structured Commands – if Statement, Grouping multiple statements, else Statements, else if Statements, Comparison conditions, Creating compound conditions, Negating a Condition check, Switch Statement; Programming Loops – Understanding Loops, while Loops, do-while loops, for Loops, Using arrays in Loops, Using multiple variables, Nesting Loops, Controlling Loops; Development of Sketches	08 Hrs
III	**Real World Interfacing** Concept of Library, Using standard libraries; Digital Interfaces – Digital overview, Working with Digital inputs and outputs; Analog Devices – Analog overview, Analog Input, Modifying input result, Using input mapping, Changing reference voltage, Analog output; Analog output dependent on digital and analog input; Overview of the spectrum of sensors and actuators compatible with Arduino family of microcontrollers. Interfacing of Sensors; Interfacing of actuators; Interfacing with LCD; Development of Sketches	12 Hrs

Text Books:

[1] R. Blum, Sams Teach Yourself Arduino Programming in 24 Hours, 1st ed. Pearson Education, 2015. ISBN: 9789332552432.

[2] S. O. F. Towaha, Learning C for Arduino, 1st ed. Packt Publishing, 2017. ISBN: 9781787120099.

Reference Books:

[1] M. McRoberts, Beginning Arduino, 2nd ed., Apress, 2013. ISBN: 9781430232407.
[2] S. Monk, Programming Arduino: Getting Started with Sketches, 2nd ed., McGraw-Hill Education, 2016. ISBN: 9781259641633.
[3] M. Margolis, Arduino Cookbook, 2nd ed., O'Reilly Media, 2011. ISBN: 9781449313876.
[4] J. Blum, Exploring Arduino: Tools and Techniques for Engineering Wizardry, 1st ed., Wiley, 2013. ISBN: 9781118549360.

Online Reference:

https://spoken-tutorial.org/tutorial-search/?search_foss=Arduino&search_language=English

IA /DSC/P/226: Embedded Systems Lab

Total Credits : 02

Total Contact Hours : 60 Hrs **Maximum Marks : 50**

Learning Objectives of the Course:

1. To introduce students with Arduino IDE
2. To provide operational exposure with sensors and actuators compatible to Arduino Uno

Course Outcomes (COs):

On completion of this course, students should be able to –

1. Identify sensors and actuators (compatible to Arduino UNO) for target applications
2. Develop basic sketches for working with sensors and actuators compatible to Arduino uno
3. Develop simple prototypes for real life applications

CO-PO-PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	H								H	H	H	H
CO2	H	H	H	H	H								H	H	H	H
CO3	H	H	H	H	H								H	H	H	H

At least six experiments have to be performed

1. Installation of Arduino IDE and getting Arduino Uno connected to IDE
2. LED interfacing to Arduino Uno: Blinking, Slow glowing/dimming of LED
3. Interfacing of potentiometer to Arduino Uno and printing of voltage developed across potentiometer in serial monitor
4. Interfacing of LM 35 to Arduino Uno and printing of temperature in serial monitor
5. Interfacing of LCD to Arduino Uno: temperature reading from LM35
6. Interfacing of LCD and temperature + humidity sensor to Arduino Uno
7. Interfacing of a flow sensor to Arduino Uno and printing of flow in serial monitor
8. Development of a distance monitor using Arduino Uno and Ultrasonic transmitter/receiver
9. Interfacing a DC motor to Arduino Uno: Using toggle switches to Start/Stop and Direction Control of Motor, Using Potentiometer to control speed of motor
10. Interfacing a DC motor to Arduino Uno (speed and direction of rotation control)
11. Interfacing DC servo motor to Arduino Uno
12. Interfacing stepper motor to Arduino Uno (using transistor/ MOSFET)

IA/DSC/T/201: Process Control

Total Credits : 02 Total Contact Hours : 30 Hrs

Maximum Marks : 50

Learning Objectives of the Course: To provide students with-

1. Fundamental traits, definitions and expressions of industrial process control
2. Application concepts of discrete, continuous and composite controller

Course Outcomes (COs) :

On completion of the course, students should be able to -

1. Discuss basic operation of controllers in different modes of operation and basic control loop characteristics
2. Explain basic characteristics industrial process and process control .
3. Evaluate role of sensors, final control elements and controllers in industrial process control

CO –PO – PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H									H	M	M	
CO2	H	H	H	H									H	M	M	
CO3	H	H	H	H									H	M	M	

Module No.	Course Content	Contact Hours
I	**Introduction to Industrial Process Control** Overview of Process Control, Role of Automation, Current trends in Automated Process Control; Fundamentals: Process Definition, Process Control Principles, Servomechanism, Discrete-State Control System, Block Diagram of Process Control, Evaluation of a typical control system, Analog and Digital Processing, Analog data Representations, Pneumatic and Current Signal	10 Hrs
II	**Process-control elements and Discrete Process Control** Basic Definitions of common terms and expressions used to describe process-control elements Overview of sensors and final control elements, Process Control Drawings: P&ID symbols, Discrete state process control: Overview, System characteristics,	10 Hrs
III	**Controller Principles** Process characteristics, Control system parameters, Open loop control, Closed loop control, Control System Parameters, Discontinuous Controller Modes: Two position control, Multi-position control, Continuous and Composite Controller Modes: Proportional, Integral and Derivative Control, PI, PD and PID control	10 Hrs

Text Books:

1. Process Control Instrumentation Technology- C. D. Johnson; PHI Learning PVT LTD, 2005; ISBN-10 : 0131194577 ISBN-13 : 978-0131194571
2. Industrial Control Electronics (Devices, Systems, Applications): T. Bartelt; Delmar Cengage Learning, 2005; ISBN-10 : 1401862926 ISBN-13 : 978-1401862923

Reference Books:

1. Fundamentals of Industrial Instrumentation and Process Control: W. Dunn; Mc-Graw Hill, 2005; ISBN-10 : 0071457356 ISBN-13 : 978-0071457354
2. Process Control: A Practical Approach: M. King, Wiley, 2011; ISBN-13: 978-0470975879 ISBN-10: 9780470975879
3. Practical Process Control: A. M. Seal, Elsevier Butterworth-Heinemann, 1998; ISBN: 9780340705902,

9780080539393

Online Reference:

1. https://nptel.ac.in/courses/103/103/103103037/
2. https://nptel.ac.in/courses/103/105/103105064/

IA /DSC/P/227 Process Control Lab

Total Credits : 02 **Total Contact Hours : 60 Hrs**

Maximum Marks : 50

Learning Objectives of the Course:

1 To provide students with operational knowledge of process control elements

2 To acquaint students with specific characteristics and limitation of process control elements in perspective of developing real life applications

Course Outcomes (COs) :

On completion of this course, students should be able to -

1 Demonstrate operation of Controllers

2 Contrast operational characteristics of valves and transmitters

3 Implement basic process control circuits

CO –PO – PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H									H	M	M	
CO2	H	H	H	H									H	M	M	
CO3	H	H	H	H									H	M	M	

At least six experiments have to be performed

1. Study of I/P converter
2. Study of P/I converter
3. Study of open and closed loop system
4. Study of basic blocks of an analogue PID controller
5. Study of basic ON/OFF controller
6. Study of proportional, integrator and derivative controller (independent action)
7. Study of controller in composite modes (PI, PD, PID)
8. Study of PID controller operation
9. Study of Temperature / Level Transmitter
10. Study of Flow / Pressure Transmitter
11. Study of installed and inherent characteristics of Equal Percent Plug
12. Study of installed and inherent characteristic of Linear Plug
13. Study of Quick Opening valve characteristic
14. Study of Industrial PID Controller
15. Study of Temperature controller

Minor Course
in
Industrial Automation

Offered by DDUKK
(Industrial Automation
Division)

IA/MN/T/200 : Semiconductor Devices

Total Credits : 02 Total Contact Hours : 30 Hrs

Maximum Marks : 50

Learning Objectives of the Course: To provide students with-

1. Basic concepts and behavior of semiconductor devices
2. Application concepts of Semiconductor devices

Course Outcomes (COs) :

On completion of the course, students should be able to -

1. Discuss basic operation of semiconductor devices used in low power and power electronics domain
2. Explain characteristics of semiconductor devices used in low power and power electronics domain . 3. Evaluate role of various Semiconductor Devices in different types applications

CO –PO – PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H									H	M	M	
CO2	H	H	H	H									H	M	M	
CO3	H	H	H	H									H	M	M	

Module No.	Course Content	Contact Hours
I	**Semiconductor Basics and Two Terminal Devices** Atomic Structure, Band Theory of Semiconductors, Types of Semiconductors, Formation of Junctions. Diode- Diode Characteristics, Diode Applications, Special Purpose Diodes	10 Hrs
II	**Three Terminal Devices** Bipolar Junction Transistor (BJT)- BJT Biasing, BJT Characteristics, BJT Applications Junction Field Effect Transistor (JFET)- JFET Biasing, JFET Characteristics, JFET Applications Metal-Oxide Semiconductor Field Effect Transistor (MOSFET)- MOSFET Biasing, MOSFET Characteristics, MOSFET Applications	10 Hrs
III	**Power Electronic Devices** Silicon Controlled Rectifier (SCR) – SCR Operation, DC Operational circuit, Turn-on/off, Gate Triggering; DIAC; TRIAC; IGBT; Application of Power electronic devices	10 Hrs

Text Books:

1. Thomas l. Floyd, "Electronic Devices", Seventh Edition, Pearson Education, 2008
2. A. P. Malvino, D. J Bates, " Electronic Principles", Seventh Indian Edition, Mc. Graw Hill, 2007
3. K.L. Rao, C.H. Saibabu,"Theory of Power Electronics", Revised Edition 2009, S.Chand and Company Ltd. 2009

Reference Books:

1. V. K. Mehta, Rohit Mehta, " Principles of Electronics", Twelfth Edition, S. Chand Publishers, 2008
2. R. Boylstad, L. Nashelsky, "Electronic Devices and Circuit Theory", Tenth Edition, Pearson, 2009
3. M. D. Singh, K.Khanchandani, " Power Electronics", Second Edition, Mc Graw Hill, 2017

Online Reference:

1. http://www.nptelvideos.in/2012/12/basic-electronics-drchitralekha-mahanta.html
2. https://nptel.ac.in/courses/122106025

IA/MN/T/201: Basic Industrial Measurements

Total Credits : 02 Total Contact Hours : 30 Hrs

Maximum Marks : 50

Learning Objectives of the Course:

To provide students with-

1. fundamental concepts of measurement and instrumentation system
2. basic modalities of industrial temperature, pressure, flow and level measurement

Course Outcomes (COs) :

On completion of the course, students should be able to-

1. Describe primary blocks of an Instrumentation System and Qualities of Measurement.
2. Select transducers as per application demand
3. Describe operation of basic transducers employed for industrial process parameter monitoring applications

CO –PO – PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	H								H	H	H	H
CO2	H	H	H	H	H								H	H	H	H
CO3	H	H	H	H	H								H	H	H	H

Module No.	Course Content	Contact Hours
I	**Necessity of Industrial Measurements and Discrete Detection Techniques** Industrial Process Overview, Sequential and Continuous Process, Process Control Loop, Instrumentation and Sensors; Industrial Data – Analog, Digital Pneumatic; Smart Sensors; Units and Standards- Basic and Derived Units, Standard Prefixes Discrete Detection of Objects, Displacement Measurement – Proximity Detectors, Photoelectric sensors, Applications of Photoelectric sensor, Selection of Photoelectric sensor. RVDT, LVDT, Ultrasonic Sensors, Photoelectric pick-up sensor (Non-contact type).	10 Hrs
II	**Pressure and Temperature Measurement** Pressure Measurement: Parameters of Pressure, Application Considerations; Measuring Instruments- Bourdon Tube, Diaphragm Pressure Sensor, Differential Pressure Sensor, Strain Gauge, Load Cells, Pressure Transducer and Transmitters, Industrial Scales and Weighing Systems Temperature Measurement: Parameters of Temperature, Application Consideration; Measuring Instruments – Thermocouples, RTD, Thermistor, IC solid state temperature sensors; Non-Contact Measurements	10 Hrs
III	**Flow and Level Measurement** Flow Measurement: Parameters of Flow, Application Considerations; Flow Calculations; Measuring Instruments Non-Electrical Measurements; Velocity Flow meter, Positive Displacement Flow meter, Mass Flow meter Level Measurement: Parameters of Flow, Application Considerations; Measuring Instruments: Point Contact Level Sensors, Continuous Level Sensors	10 Hrs

Text Books:

1. William C. Dunn, "Introduction to Instrumentation, Sensors and Process Control", Artech House Publishers, 2005
2. Thomas E. Kissell, "Industrial Electronics", Third Edition, PHI Learning Pvt. Ltd., 2012
3. Terry Bartlet, " Industrial Electronics" Cengage Learning India Edition, Second Indian Reprint, 2006

Reference Books:

1. H S Kalsi, "Electronic Instrumentation and Measurements", Fourth Edition, Mc Graw Hill, 2019
2. S.K.Singh," Industrial Instrumentation & Control", Third Edition, Tata McGraw Hill Publishing Co.

Ltd; 2009
3. D. Patranabis," Principles of Industrial Instrumentation", Second Edition, Tata McGraw Hill Publishing Co. Ltd; 2008

Online Reference:

1. http://www.nptelvideos.in/2012/11/industrial-instrumentation.html

Generic / Open Elective (GE/OE) Offered by DDUKK (Industrial Automation Division)

IA/GE/OE/T/200: Embedded Systems

Total Credits : 02

Total Contact Hours : 30 Hrs Maximum Marks : 50

Learning Objectives of the Course:

4. To provide students foundational knowledge of Embedded C Programming
5. To Provide students with functional knowledge with Arduino Uno
6. To provide students with basic idea of prototyping

Course Outcomes (COs) :

On completion of the course, students should be able to -

3. Apply concepts to embedded C to develop programs in Arduino IDE
4. Develop prototypes with Arduino UNO

CO-PO-PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	H								H	H	H	H
CO2	H	H	H	H	H								H	H	H	H
CO3	H	H	H	H	H								H	H	H	H

Module No.	Course Content	Contact Hours
I	**Introduction to Arduino and Programming Environment** Introduction - What is Arduino, Introduction to Arduino family, Arduino Shields; Creating an Arduino Programming Environment – Exploring microcontroller Internals, Moving beyond machine codes, Creating Arduino programs, Installing the Arduino IDE, Overview of Arduino IDE, Exploring IDE – Menus, Toolbar, Message Area and Console Window, Setting Up Arduino IDE, Using Serial Monitor; Building a Basic Arduino sketch, Interfacing Concept with Electronic Circuits	10 Hrs
II	**Hydraulic Elements in Design of Circuits - I** Basics of C - Working with variables, Operators, Exploring Arduino functions; Structured Commands – if Statement, Grouping multiple statements, else Statements, else if Statements, Comparison conditions, Creating compound conditions, Negating a Condition check, Switch Statement; Programming Loops – Understanding Loops, while Loops, do-while loops, for Loops, Using arrays in Loops, Using multiple variables, Nesting Loops, Controlling Loops; Development of Sketches	08 Hrs
III	**Real World Interfacing** Concept of Library, Using standard libraries; Digital Interfaces – Digital overview, Working with Digital inputs and outputs; Analog Devices – Analog overview, Analog Input, Modifying input result, Using input mapping, Changing reference voltage, Analog output; Analog output dependent on digital and analog input; Overview of the spectrum of sensors and actuators compatible with Arduino family of microcontrollers. Interfacing of Sensors; Interfacing of actuators; Interfacing with LCD; Development of Sketches	12 Hrs

Text Books:

[1] R. Blum, Sams Teach Yourself Arduino Programming in 24 Hours, 1st ed. Pearson Education, 2015. ISBN: 9789332552432.

[2] S. O. F. Towaha, Learning C for Arduino, 1st ed. Packt Publishing, 2017. ISBN: 9781787120099.

Reference Books:
[1] M. McRoberts, Beginning Arduino, 2nd ed., Apress, 2013. ISBN: 9781430232407. [2] S. Monk, Programming Arduino: Getting Started with Sketches, 2nd ed., McGraw-Hill Education, 2016. ISBN: 9781259641633. [3] M. Margolis, Arduino Cookbook, 2nd ed., O'Reilly Media, 2011. ISBN: 9781449313876. [4] J. Blum, Exploring Arduino: Tools and Techniques for Engineering Wizardry, 1st ed., Wiley, 2013. ISBN: 9781118549360.
Online Reference: https://spoken-tutorial.org/tutorial-search/?search_foss=Arduino&search_language=English

Vocational Skill Courses (VSC)

IA/VSC/T/200: Industrial AC Motors

Total Credits : 01

Total Contact Hours : 15 Hrs Maximum Marks : 25

Learning Objectives of the Course:

1. 1. To provide students with fundamental knowledge in dynamics and control of electric motors.
2. 2. To equip students with basic wiring knowledge of standard industrial ac motors.

Course Outcomes (COs) :

On completion of the course, students should be able to -

1. Discuss different modes of Induction motor speed control
2. Accomplish wiring and working with a standard industrial ac motors

CO-PO-PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	L								H	H	H	L
CO2	H	H	H	H	L								H	H	H	L
CO3	H	H	H	H	L								H	H	H	L

Module No.	Course Content	Contact Hours
I	**Fundamentals of Induction Motor Drives and Control Techniques** Induction Motor Drives, Basic operation of three phase induction motor, operation with nonsinusoidal supply, Stator current of Induction motor with non-sinusoidal supply, operation of Induction motor with Unbalanced Voltage Supply, Single Phasing of Induction Motor, Braking of Induction Motor, Dynamic Braking (Ac and DC) Speed control of induction motor using stator voltage regulator, Variable Voltage/Variable Frequency Control of Induction Motor, Open Loop V/F Control, Slip Speed Control of Induction Motor, Constant Volt/ Hz Control of Induction Motor, Closed Loop Volt/ Hz Control of Induction Motor with Slip Speed Regulation, Multi Quadrant Operation of Induction Motor Drive	09 Hrs
II	**Industrial Applications of Electrical Drives and Automation** Steel Mills, Cement Mills, Textile Mills, Sugar Mills, Electric Traction, Machine Tools	06 Hrs

Text Books:

1. A First Course On Electrical Drives (SECOND EDITION)S. K. Pillai; 2001;; New Age International PVT LTD ; New Delhi (India), ISBN- 81-224-0166-X

2. Electrical Drives; N. K. DEP. K. SEN; Prentice Hall of India Private Limited; New Delhi (India), ISBN-978-81-203-1492-4

Reference Books:

1. Fundamentals of Electrical Drives (SECOND EDITION) Gopal K Dubey; 2001;; Narosa Publishing House; New Delhi (India)
2. Fundamentals of Electrical Drives; Veltman André, PulleDuco W.J., de Doncker R.W.; Springer Netherlands

Online Reference:

1. https://nptel.ac.in/courses/108/104/108104140/
2. https://www.nptel.ac.in/courses/108102046/

IA / VSC /P/226: Industrial AC Motors Lab

Total Credits : 01

Total Contact Hours : 30 Hrs

Maximum Marks : 25

Learning Objectives of the Course:

1. To develop hands-on skills in connecting and operating three-phase induction motors using various starters and understanding their internal components.
2. To enable students to measure and analyze performance characteristics, such as speed-torque and slip, of induction motors through practical experiments.

Course Outcomes (COs):

On completion of this course, students should be able to –

1. Connect, start, and operate three-phase induction motors using DOL, star-delta, and auto-transformer starters, and reverse their direction of rotation.
2. Analyze and measure speed-torque characteristics and slip of single-phase and three-phase induction motors through experimental setups

CO-PO-PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	H								H	H	H	H
CO2	H	H	H	H	H								H	H	H	H
CO3	H	H	H	H	H								H	H	H	H

At least four experiments have to be performed

1. Identify components and terminals of a three-phase induction motor.
2. Connect an automatic star-delta starter with three contactors.
3. Operate a three-phase induction motor using DOL, star-delta, and auto-transformer starters.
4. Operate and analyze performance of a slip-ring induction motor with rotor resistance starter.
5. Study speed-torque characteristics of a single-phase capacitor-start induction motor.
6. Measure slip in a squirrel cage three-phase induction motor.
7. Study speed-torque characteristics of a squirrel cage three-phase induction motor.
8. Determine transformer equivalent circuit using open-circuit and short-circuit tests.
9. Perform maintenance, servicing, and troubleshooting of AC motor starters.

IA/ VSC /T/201: Variable Frequency Drives

Total Credits : 01

Total Contact Hours : 15 Hrs Maximum Marks : 25

Learning Objectives of the Course:

1. To enable students towards recognition/identification for need of appropriate drives for different applications.
2. To equip students with basic wiring and programming knowledge of standard industrial VFD.

Course Outcomes (COs) :

On completion of the course, students should be able to -

1. Discuss need of appropriate drives for different applications
2. Accomplish wiring and basic programming with a standard industrial VFD

CO-PO-PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	L								H	H	H	L
CO2	H	H	H	H	L								H	H	H	L
CO3	H	H	H	H	L								H	H	H	L

Module No.	Course Content	Contact Hours
I	**Fundamentals of Drives:** AC Motor Drive Fundamentals , Variable-Frequency Drives (VFD), Volts per Hertz Drive, Flux Vector Drive	05 Hrs
II	**Industrial Applications of Electrical Drives and Automation** VFD Fundamentals, Pulse width modulation, carrier frequency, fundamental frequency, control modes for speed and torque; Cold test to check the healthiness of VFD; Connection of cables to the power terminals, Continuity test with the help of as per drawings. Drive installation and programming (Based on standard Allen Bradley/Siemens/Mitsubishi/ABB/Delta VFD) : common wiring connection, equipment/components used in typical VFD panel, parameters and programming, menu navigation and LCD display, common parameters, braking method; basic troubleshooting in VFD- over temperature fault, over current fault, over voltage fault.	10 Hrs

Text Books:

1. Variable Frequency Drives: Installation and Troubleshooting – Gary D. Anderson; ISBN- 978-15-027-7089-9

2. Electrical Drives; N. K. DEP. K. SEN; Prentice Hall of India Private Limited; New Delhi (India), ISBN-978-81-203-1492-4

Reference Books:

1. Fundamentals of Industrial Drives; B. N. Sarkar; Prentice Hall of India Private Limited; New Delhi (India)
2. Industrial Electronics: Circuits, Instrument and Control Technique Terry Bartlet; 2006; (INDIA EDITION); Cengage Learning India PVT LTD; Delhi (India)

Online Reference:

1. https://nptel.ac.in/courses/108108077/35
2. https://nptel.ac.in/courses/108104011/2
3. https://youtube.com/playlist?list=PLRLTfp5JUl6SRefy1tSAtYkC8fDP9uk8B&si=mgyQniBh6qHwddPA

IA / VSC/P/227: Variable Frequency Drives Lab

Total Credits : 01

Total Contact Hours : 30 Hrs | Maximum Marks : 25

Learning Objectives of the Course:

1. To acquire practical skills in installing, wiring, and configuring a variable frequency drive (VFD) for motor control applications.
2. To develop the ability to operate and troubleshoot a VFD using digital keypads, external terminals, and various control modes.

Course Outcomes (COs):

On completion of this course, students should be able to –

1. Install, wire, and configure a variable frequency drive (VFD) by setting motor parameters and performing a trial run using digital keypad controls.
2. Operate and control motor speed using VFD through keypad potentiometer, external terminals, and NPN/PNP 2-wire/3-wire configurations.

CO-PO-PSO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	H								H	H	H	H
CO2	H	H	H	H	H								H	H	H	H
CO3	H	H	H	H	H								H	H	H	H

At least four experiments have to be performed

1. Reading Motor Nameplate and Specifications
2. Installation of Variable Frequency Drive (VFD)
3. Power and Control Wiring for VFD
4. Operation of VFD Using Digital Keypad
5. Resetting VFD to Factory Default Settings
6. Configuration of Motor-Related Parameters in VFD
7. Trial Run of VFD Using Digital Keypad Controls
8. Speed Control of Motor Using Keypad Potentiometer
9. Operation of VFD Using External Terminals
10. NPN/PNP 2-Wire and 3-Wire Control Modes
11. Controlling Motor Speed with VFD