Republic of the Philippines
SULTAN KUDARAT STATE UNIVERSITY
Isulan Campus, Isulan Sultan Kudarat
College of Industrial Technology

ELX 322 – INDUSTRIAL ROBOTICS

UNIVERSITY VISION

A leading University in advancing scholarly innovation, multi-cultural convergence, and responsive public service in a borderless Region.

UNIVERSITY MISSION

The University shall primarily provide advanced instruction and professional training in science and technology, agriculture, fisheries, education and other related fields of study. It shall also undertake research and extension services, and provide progressive leadership in its areas of specialization.

UNIVERSITY STRATEGIC GOALS

a. Deliver quality service to stakeholders to address current and future needs in instruction, research, extension, and production
b. Observe strict implementation of the laws as well as the policies and regulations of the University
c. Acquire with urgency state-of-the-art resources for its service areas
d. Bolster the relationship of the University with its local and international customers and partners
e. Leverage the qualifications and competences in personnel action and staffing
f. Evaluate the efficiency and responsiveness of the University systems and processes

INSTITUTIONAL OUTCOMES (IO)

a. Enhance competency development, commitment, professionalism, unity and true spirit of service for public accountability, transparency and delivery of quality services
b. Provide relevant programs and professional trainings that will respond to the development needs of the region
c. Strengthen local and international collaborations and partnerships for borderless programs
d. Develop a research culture among faculty and students
e. Develop and promote environmentally-sound and market-driven knowledge and technologies at par with international standards
f. Promote research-based information and technologies for sustainable development
g. Enhance resource generation and mobilization to sustain financial viability of the university

PROGRAM OUTCOMES (PO) COMMON TO ALL PROGRAMS AND ITS RELATIONSHIPS TO INSTITUTIONAL OUTCOMES

A graduate of the BIndTech program can:	INSTITUTIONAL OUTCOMES (IO)						
	a	b	c	d	e	f	g
a. Analyze broadly defined industrial technology processes by using analytical tools that enhance creativity, innovativeness, and intellectual curiosity to improve methods, processes, and systems that meet the industry standards;	✓	✓				✓	
b. Design and implement broadly defined industrial systems, components, products, or processes to meet specific industry needs with proficiency and flexibility in the area of specialization in accordance with global standards;	✓	✓		✓		✓	

c. Apply appropriate techniques, resources, and state-of-the-art industrial technology tools to meet current industry needs and use these modern tools and processes to improve and increase entrepreneurial activities upholding the safety and health standards of business and industry;	✓		✓	✓	✓		
d. Communicate with diverse groups of clienteles the appropriate cultural language with clarity and persuasion, in both oral and written forms, including understanding and giving of clear instructions, high comprehension level, effectiveness in delivering presentations and writing documents, and articulating technological innovation outputs;	✓	✓	✓	✓	✓		
e. Develop leadership and management skills in a team-based environment by making informed decisions, keeping the team motivated, acting and delegating responsibility, and inspiring positive changes in the organization by exercising responsibility with integrity and accountability in the practice of one's profession;	✓	✓	✓	✓	✓		
f. Practice the moral responsibilities of an industrial technologist to manage and balance wider public interest and uphold the norms and safety standards of the industrial technology profession;				✓	✓	✓	✓
g. Demonstrate enthusiasm and passion for continuous personal and professional development in broadly defined industrial technology and effecting positive changes in the entrepreneurial and industrial endeavor; and	✓	✓	✓	✓	✓	✓	✓
h. Recognize the need for, and an ability to engage in lifelong learning.	✓	✓	✓	✓	✓	✓	✓

1 COURSE CODE ELX 322
2 COURSE TITLE Industrial Robotics
3 PREREQUISITE ELX 311
4 CREDITS 3 units

5 COURSE DESCRIPTION
The course integrates all laboratory applications in Sensor Technology, Electro-Pneumatics, Instruments and Process Control, and Programmable Logic Controllers. It includes Network Controller, Transmission Control Protocol-Internet Protocol (TCP/IP), Industrial Internet of Things (IIoT), Human-Machine Interface, Image Graphical Recognition, Open Platform Communication-Unified Architecture (OPC-UA), and Object-Linking and Simulation-Based Technology.

6 COURSE LEARNING OUTCOMES (CLO) AND ITS RELATIONSHIPS TO PROGRAM OUTCOMES

Course Learning Outcomes (CLO)	Program Outcomes						
At the end of the course, a student can:	a	b	c	d	e	f	g
a. Understand SKSU-VGMO, Classroom Policies, Course Overview, Course Requirements and Grading System;	✓	✓	✓	✓	✓	✓	✓
b. To design and implement industrial robotic systems integrating sensor technology, electro-pneumatics, and process control, demonstrating proficiency in selecting and configuring components to meet specific application requirements.	✓	✓	✓	✓	✓	✓	✓
c. To program and troubleshoot Programmable Logic Controllers (PLCs) and Network Controllers, utilizing protocols such as Transmission Control Protocol-Internet Protocol (TCP/IP) and Open Platform Communication-Unified Architecture (OPC-UA) to enable seamless communication and integration within industrial automation networks;	✓	✓	✓	✓	✓	✓	✓

d. To develop Human-Machine Interface (HMI) solutions to facilitate intuitive interaction and control of robotic systems, incorporating image and graphical recognition techniques to enhance user experience and productivity.	✓	✓	✓	✓	✓	✓	
e. To implement simulation-based technologies to model and validate robotic system behavior, enabling virtual testing and optimization of control strategies before deployment in real-world environments;	✓	✓	✓	✓	✓	✓	
f. To integrate advanced robotics technologies with existing industrial processes, considering factors such as safety, efficiency, and scalability to maximize the impact of automation on production workflows.	✓	✓	✓	✓	✓	✓	✓
g. To collaborate effectively with multidisciplinary teams to identify opportunities for automation, assess feasibility, and design tailored robotic solutions to address specific manufacturing challenges.	✓	✓	✓	✓	✓	✓	✓
h. To demonstrate proficiency in the installation, configuration, and commissioning of robotic systems, ensuring compliance with relevant standards and regulations while optimizing performance and reliability.	✓	✓	✓	✓	✓	✓	✓
i. To analyze and interpret data collected from robotic systems using IIoT-enabled sensors and analytics tools, identifying patterns, trends, and opportunities for process improvement and optimization.	✓	✓	✓	✓	✓	✓	✓

7 COURSE CONTENTS

WEEK	CONTENT	INTENDED LEARNING OUTCOMES((ILOs)	TEACHING AND LEARNING ACTIVITIES (TLA)	OUTCOMES-BASED ASSESSMENT (OBA)	COURSE LEARNING OUTCOMES (CLOs)
1	**Course Orientation** *SKSU VMGO, Classroom Policies, Course Overview, Course Requirements, Grading System*	At the end of the week, the student can: a. Discuss the University's VMGO, classroom policies, course overview, requirements and grading system	Discuss the VMGO of the University, the classroom policies, scope of the course, course requirements and grading system	a. Participation in discussions	abcdefg
2	**Overview of Robotic System** a. Introduction to industrial robotics: history, principles of operation, applications. Integration with sensor technology: types of sensors, sensor fusion, sensor integration in robotics. Integration with electro-pneumatics: pneumatic actuators, control valves, pneumatic	At the end of the week, the students can: a. Discuss the principles of industrial robotics and its integration with sensor technology, electro-pneumatics, and process control b. Explore advanced topics in industrial robotics, including network communication protocols, IIoT, and human-machine interface (HMI) c. Gain practical experience in industrial robotics through simulation-based technology and image-based recognition	a. Video/PowerPoint presentation b. Lecture presentations, demonstrations c. Laboratory experiments, software simulations, case studies d. Hands-on laboratory exercises, simulation software usage e. Activity 2.1 Group Research Project on Robotic Types	a. Quiz on industrial robotics fundamentals - Laboratory experiments on sensor integration, electro-pneumatics, and process control b. Project on implementing c. IIoT in industrial robotics d. Design and development of HMI for industrial robot control e. Simulation-based project on robot programming and optimization f. Image recognition project using vision systems	abcdefg

	circuits. Integration with process control: basics of process control, feedback control loops, PLC integration b. Network communication protocols: TCP/IP, OPC-UA, Ethernet/IP. Industrial Internet of Things (IIoT): concepts, applications, integration with robotics. Human-machine interface (HMI): design principles, touchscreen interfaces, HMI integration with industrial robots c. Simulation-based technology: virtual commissioning, robot simulation software, offline programming. Image graphical recognition: vision systems, image processing techniques, object detection and tracking			g. Group Presentation and Report	
3	**2.0 Central Processing Unit** a. Overview of the Manual of Professional Practice: objectives, structure, key provisions b. CPU design methodologies: instruction set architecture (ISA), pipelining, caching, branch prediction c. CPU programing languages and tools:	At the end of the week, the students can: a. Explain the fundamental principles of central processing units (CPUs) and their role in computing systems b. Explore advanced topics in CPU design and optimization techniques c. Integrate practical experience in CPU programming and interfacing	a.Lecture presentations, discussions b.interactive sessions c.Hands-on exercises, case studies, d.research assignments e.Laboratory experiments, programming assignments, projects f. Activity 3.1 Laboratory experiments	a. Quiz on CPU fundamentals b. Class participation and engagement c. Design project on optimizing CPU performance d. Case study analysis e. Programming assignments on CPU assembly language	abcdefg

	assembly language, high-level languages, development environments.				
4	**I/O System Configuration** a. Introduction to Transducers and Sensors: definition, types, basic principles of operation b. Classification of Transducers and Sensors: resistive, capacitive, inductive, optical, piezoelectric, etc. Characteristics such as accuracy, sensitivity, linearity, and resolution c. Signal Conditioning Techniques for Transducers and Sensors. Interfacing sensors with microcontrollers, PLCs, and data acquisition systems	At the end of the week, the students can: a. Understand the principles and applications of transducers and sensors in electronic/electrical control and instrumentation systems b. Learn different types of transducers and sensors and their characteristics c. Gain practical experience in interfacing and integrating transducers and sensors into control and instrumentation systems	a. Lecture presentations, discussions b. interactive sessions c. Hands-on exercises, case studies, d. research assignments e. Activity 4.1 Laboratory experiments, interface design projects	a. Quiz on basic concepts of transducers and sensors b. Class participation in discussions c. Identification and characterization of various sensors d. Laboratory experiments on sensor performance e. Design and implementation of sensor interfaces f. Laboratory reports on interface performance	abcdefg
5	**Programming Terminals and Peripherals** a. Introduction to programming terminals and peripherals: types, features, and functions. Configuration of HMI devices, communication protocols, and peripheral devices	At the end of the week, the students can: a. Recognize the functions and configurations of programming terminals and peripherals used in industrial automation systems b. Apply programming techniques to configure and customize programming terminals and peripherals for specific industrial applications c. Analyze and troubleshoot programming terminals and	a. Lecture presentations, discussions b. interactive sessions c. Hands-on exercises, case studies, d. research assignments e. Activity 5.1 Laboratory experiments, troubleshooting scenarios, simulation exercises	a. Quiz on programming terminal fundamentals b. Class participation in discussions c. Design project on programming terminal customization. d. Laboratory experiments on sensor performance e. Design and implementation of sensor interfaces f. Laboratory reports on project	abcdefg

	b. Programming languages and software tools for HMI development. Configuration of input/output devices, alarms, and data logging. Customization of user interfaces and navigation structures c. Troubleshooting techniques: diagnostics, debugging, error handling. Interfacing with PLCs, SCADA systems, and other control devices. Testing and validation of programmed functionality	peripherals to ensure proper functionality and integration within industrial systems			
6			**MIDTERM EXAM**		
7	**Network Configuration** a. Introduction to network configuration: basics of networking, network topologies, protocols, and communication standards b. Configuration of network devices: routers, switches, gateways. Implementation of	At the end of the week, the students can: a. Understand the principles of network configuration in industrial automation systems b. Apply networking concepts to configure and troubleshoot industrial networks c. Analyze and evaluate network configurations to optimize performance and ensure reliability in industrial environments	a. Lecture presentations, discussions b. interactive sessions c. Hands-on exercises, case studies, d. research assignments e. Activity 7.1 Laboratory experiments, interface design projects	a. Quiz on network configuration fundamentals b. Class participation and engagement c. Design a project on configuring an industrial network d. Case study analysis e. Performance analysis of configured networks f. Final project	abcdefg

	TCP/IP, Ethernet/IP, and other industrial protocols. Troubleshooting techniques for network connectivity and performance issues c. Network optimization strategies: bandwidth management, Quality of Service (QoS), security measures. Evaluation of network performance metrics and monitoring **techniques**				
8	**Data Acquisition** a. Introduction to data acquisition: principles, types of data, sensors, and measurement devices. Data acquisition systems architecture and components b. Sensor types and characteristics: analog, digital, temperature, pressure, flow sensors. Data acquisition methods and signal conditioning techniques. Data processing and analysis using software tools c. Calibration and testing of data acquisition systems. Troubleshooting	At the end of the week, the students can: a. Understand the principles of data acquisition and its applications in industrial automation systems b. Apply data acquisition techniques to collect, process, and analyze data from various industrial sensors and devices c. Evaluate and optimize data acquisition systems to ensure accuracy, reliability, and compatibility with industrial control systems	a. Lecture presentations, discussions b. interactive sessions c. Hands-on exercises, case studies, d. research assignments e. Activity 8.1 Laboratory experiments, troubleshooting scenarios, simulation exercises	a. Quiz on data acquisition fundamentals b. Class participation and engagement c. Data acquisition project d. Case study analysis e. Performance evaluation of data acquisition systems f. Final project	abcdefg

	techniques for data acquisition errors and anomalies. Integration with PLCs, SCADA systems, and other control devices				
9	**Human Machine Interface (HMI)** **a.** Introduction to Human-Machine Interface (HMI): definition, history, and evolution. Importance of HMI in industrial control systems b. Use interface design principles: usability, accessibility, feedback mechanisms, and ergonomic considerations. HMI design tools and software c. Advanced HMI features: data visualization techniques, alarm management systems, remote monitoring and control functionalities. HMI integration with PLCs and SCADA systems	At the end of the week, the students can: a. Analyze the principles and importance of human-machine interface (HMI) in industrial automation systems b. Evaluate and design effective HMIs for various industrial applications considering user interface design principles and ergonomic factors c. Create and implement HMI solutions integrating advanced features such as data visualization, alarm management, and remote monitoring	a. Lecture presentations, case studies, group discussions b. Hands-on HMI design workshops, software tutorials, design critique sessions c. Simulation exercises, PLC-HMI integration labs, project demonstrations.	Case study analysis	abcdefg
9	**Closed Loop Technology** a. Overview of closed-loop control systems: definition, components, and operation. Types of	At the end of the week, the students can: a. Analyze the principles and applications of closed-loop control systems in industrial automation b. Evaluate the performance and stability of closed-loop control systems using	a. Lecture presentations, case studies, group discussions b. Hands-on simulation sessions, MATLAB/Simulink tutorials, stability analysis laboratory c. PLC programming labs, SCADA system design workshops, project	a. Case study analysis b. Participation in discussions c. Simulation project d. Stability analysis report e. PLC-SCADA integration project f. System performance evaluation	abcdefg

	closed-loop control systems: PID control, feedback control, and adaptive control b. Mathematical modeling of closed-loop control systems: transfer functions, block diagrams, and stability analysis. Simulation tools for closed-loop control systems: MATLAB/Simulink, LabVIEW c. PLC-based closed-loop control systems: programming techniques, ladder logic, and PLC-SCADA integration. SCADA systems for closed-loop control: design principles, data visualization, and alarm management	mathematical modeling and simulation techniques c. Create and implement closed-loop control strategies for various industrial processes using Programmable Logic Controllers (PLCs) and Supervisory Control and Data Acquisition (SCADA) systems	demonstrations		
10	**FINAL EXAMINATION**				

Total No. of Hours : 54

8 COURSE REQUIREMENTS AND COURSE POLICIES

COURSE REQUIREMENTS

Each student is required to:

1. submit accomplished assignments, and activities;
2. make a PowerPoint presentation, and a written summary of the assigned report;
3. participate actively in all discussion;
4. discuss an assigned topic to report and participate in class discussions; and
5. pass the major exams (midterm and final)

COURSE POLICIES

Attendance: A student will be marked late if he/she enters the class 5 minutes after start of class period. Any student who comes to class 15 minutes after the scheduled time or always late for three consecutive meetings shall be marked absent.

Missed work or exam: Any student who missed to submit a work assignment or to take a test should consult the concerned instructor for immediate compliance

Cheating and Plagiarism: Any student who committed any form of academic dishonesty (e.g., copy-paste plagiarism) shall be given disciplinary action provided in the SKSU Student's Handbook

Use of Technology: Cell phones should be turned off while the session is in progress. Using laptops, notebook PCs, smart phones, and tablets shall be allowed only when needed. A scientific calculator (e.g. Casio fx-991ES) shall be utilized in solving.

9 GRADING SYSTEM AND RUBRICS FOR GRADING

GRADING SYSTEM

Midterm Grade

Midterm Examination	50%
Attendance/ Class Participation	5%
Quizzes	5%
Recitation	5%
Activity	20%
Report	15%
TOTAL	100%

Final Term Grade

Final Term Examination	50%
Attendance/Class Participation	5%
Quizzes	5%
Recitation	5%
Activity	20%
Report	15%
TOTAL	100%

FINAL GRADE

Midterm Grade	50%
Final Term Grade	50%
TOTAL	**100%**

Materials used: Laptop, Powerpoint presentations and video clips
Books, Magazines, Online slides, Teacher-made slides

References:

Larry Ross (1987) Robotics: Theory and Industrial Applications

Peter Mckinnon (2018)Robotics: Everything You Need to Know About Robotics from Beginner to Expert

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