MINOR DEGREE
in
Robotics and Automation

Mechanical Engineering Department
Faculty of Technology
Dharmsinh Desai University
Nadiad – 387 001, Gujarat, India

(Effective from 2025-26)

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Preface:

With a view to enhance the employability skills and impart deep knowledge in emerging areas which are usually not being covered in Undergraduate Degree credit framework, AICTE has recommended the concept of "Minor Degree" in emerging areas and Dharmsinh Desai University, Nadiad has decided to offer the same for the benefit of the students. As per the recommendation of AICTE, approved Institution/programs can start a course of 18-20 additional credits in the emerging area for the students of the same program or other programs in the Institutions.

The Minor in Robotics and Automation aims to impart specialized knowledge and skills in robotics and automation required by engineers to the current demands of various industrial sectors. Automobile, aerospace and defense, logistics engineering and factory automation companies are currently asking for engineering graduates with add-on skills in these areas. Several sectors of industry need the newly recruited engineers with knowledge and skills in automation, robotics, and mechatronics. Currently, the need of core courses of any B.Tech. program of the Institute limits sufficient coverage of these topics in the existing core and hence the only way students can complement their learning with these specialized courses is through a minor program. This minor program has been designed by keeping that need in focus.

Eligibility for the student and registration:

- Honor / Minor program is an additional credential a student may earn if she/he does 18 credits worth of additional courses in a discipline other than her/his major discipline of B.Tech. degree.
- Students, may be permitted to do one minor/one honors.
- Number of credits for earning Minor specialization is 18 with courses, as prescribed by the Department.
- Courses for Minor specialization start from 5th Semester and the student is required to register for courses as per the Minor degree structure.
- After successful completion of the Minor specialization requirements, the student will be awarded a degree in "name of the discipline" with minor specialization in "name of the minor specialization".

Examples:

Computer Engineering -> Minor Course in Cyber Security (18-20 Credits)

Mechanical Engineering -> Minor Course in Robotics and Automation (18-20 Credits)

Case- 1: Within a discipline, the degree to be offered as…

B. Tech. (Hons.) Computer Engineering with Specialization in Cyber Security

B. Tech. (Hons.) Mechanical Engineering with Specialization in Robotics and Automation

Case-2: Interdisciplinary, the degree to be offered as…

B. Tech. Computer Engineering with a minor degree in Robotics and Automation

B.Tech. Mechanical Engineering with a minor degree in Cyber Security

In case a student drops from the Minor after earning a certain number of credits or is NOT able to fulfil all the requirements for the certification of Minor, within the maximum period of study permitted by UGC, the student will not receive the certification. Nevertheless, the transcript will be issued for whatever credits he/she has earned.

TEACHING SCHEME FOR HONOR / MINOR DEGREE
IN
ROBOTICS AND AUTOMATION

Subject Code	Subject Title	Lect	Tut	Prac	Credits	semester
ROB01	Introduction to Robotics	3	1	0	4	V
ROB02	One course from NPTEL Group – I*	2	0	0	2	--
ROB03	Industrial Automation	4	0	0	4	VI
ROB04	One course from NPTEL Group – II*	3	0	0	3	--
ROB05	Automation, control and Programming lab	0	0	6	3	VII
ROB06	One course from NPTEL Group – III*	2	0	0	2	--
		14	1	6	18	

* Or equivalent content and duration another course offered by NPTEL

Out of the above mentioned six courses, **ROB01**, **ROB03** and **ROB05** will be conducted by the department. To get the credits of the remaining courses i.e., **ROB02**, **ROB04** and **ROB06**, students have to register and get a certificate of any one course from each of the three groups of NPTEL courses as mentioned.

NPTEL Group- I (Students shall choose one course from this list as ROB02)

Sr. No.	Course Title	Course duration	Course code
1.	Robotics	8 weeks	112105249
2.	Mechanism and Robot Kinematics	8 weeks	112105236
3.	Mechanics and Control of Robotic Manipulators	8 weeks	112106304

NPTEL Group- II (Students shall choose one course from this list as ROB04)

Sr. No.	Course Title	Course duration	Course code
1.	Control systems	12 weeks	107106081
2.	Industrial Automation and Control	12 weeks	108105088
3.	Sensors and Actuators	12 weeks	108108147
4.	Microprocessors and Microcontrollers	12 weeks	108105102

NPTEL Group- III (Students shall choose one course from this list as ROB06)

Sr. No.	Course Title	Course duration	Course code
1.	Wheeled Mobile Robots	8 weeks	112106298
2.	Advanced Robotics Applications	8 weeks	112104620

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HONOR / MINOR – ROBOTICS AND AUTOMATION
SUBJECT: (ROB01) INTRODUCTION TO ROBOTICS (w.e.f. 2025-26)

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
3	1	0	60	40	-	-	100	3	1	0	4

DETAILED SYLLABUS:

1 INTRODUCTION TO ROBOTICS

Brief History, basic concepts of robotics such as definition, three laws, elements of robotic systems i.e. robot anatomy, DOF, misunderstood devices etc., classification of robotic systems on the basis of various parameters such as work volume, type of drive, etc., associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device etc., Industrial applications of robot

2 DRIVES AND CONTROL FOR ROBOTICS

Types of drives – Hydraulic, Pneumatic and Electric, comparison of all such drives, DC servo motors, stepper motors, AC servo motor – salient features and applications, control system in robotics

3 ROBOT END EFFECTOR

Definition and types of end effector, grippers for robotics - types of grippers, guidelines for design for robotic gripper, force analysis for various basic gripper system, tools used as end effector

4 SENSORS FOR ROBOTICS

Sensors for robots - types of sensors used in robotics, classification and applications of sensors, characteristics of sensing devices, selections of sensors. need for sensors and vision system in the working and control of a robot

5 PROGRAMMING AND LANGUAGES FOR ROBOTICS

Robot Programming: methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, programming languages: generations of robotic languages, Introduction to various types such as VAL, RAIL, AML, Python, ROS etc., development of languages since WAVE till ROS

6 RELATED TOPICS IN ROBOTICS

Socio-Economic aspect of robotization. Economical aspects for robot design, Safety for robot and standards, new trends & recent updates in robotics

TEXT/REFERENCE BOOKS:

1. Groover, M.P., 1986. Industrial Robotics: Technology, Programming, and Applications. McGraw-Hill.
2. Niku, S.B., 2011. Introduction to Robotics: Analysis, Systems, Applications. 2nd edn. PHI Learning.
3. Shahinpoor, M.,1987. A Robot Engineering Textbook. Harper & Row.
4. Craig, J.J., 2005. Introduction to Robotics: Mechanics and Control. 3rd edn. Pearson Education.
5. Schilling, R.J., 1990. Fundamentals of Robotics: Analysis and Control. PHI Learning.
6. Hegde, G.S., 2010. Industrial Robots. Laxmi Publications.
7. Holz, W.G., 1984. Robotic Technology: Principles and Practice. Van Nostrand Reinhold.
8. Klafter, R.D., Chmielewski, T.A. & Negin, M., 1989. Robotic Engineering: An Integrated Approach. PHI Learning.

COURSE OUTCOMES

After successful completion of the course, students will be able to:

CO1	Understand Basics of Robotics, various configuration of robots and parameters related to robotic system.
CO2	Understand different types of drive systems used and robot control System.
CO3	Evaluate different types of robot end effector
CO4	Analyze about different types of sensors for robotics
CO5	Understand programming of robot
CO6	Understand various aspects of robotics like Socio-Economic, Economical and recent trends in the field of robotics

COURSE ARTICULATION MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	-	-	-	-	-	1	-	2	1	1
CO2	2	2	2	-	-	-	-	-	1	-	2	1	1
CO3	2	2	2	-	1	-	-	-	1	-	2	2	2
CO4	2	2	2	-	1	-	-	-	1	-	2	2	2
CO5	2	1	2	-	1	-	-	-	1	-	2	2	2
CO6	2	1	2	-	1	-	-	-	1	-	2	2	2

1-Slightly; 2-Moderately; 3-Substantially

HONOR / MINOR – ROBOTICS AND AUTOMATION
SUBJECT: (ROB03) INDUSTRIAL AUTOMATION (w.e.f. 2025-26)

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
4	0	2	60	40	25	25	150	4	0	1	5

DETAILED SYLLABUS:

1 INTRODUCTION

Automation in production system, principles and strategies of automation, basic elements of an automated system, advanced automation functions, levels of automation, automated flow lines and transfer mechanisms, analysis of transfer lines without storage, automated flow lines with storage buffers

2 AUTOMATED MANUFACTURING SYSTEMS

Material handling and identification technologies -Overview of material handling systems, types of material handling equipment, design of the system, conveyor system, automated guided vehicle system, automated storage systems, interfacing handling and storage with manufacturing, overview of automatic identification methods

Automated Manufacturing Systems-Components, classification and overview of manufacturing systems, cellular manufacturing, flexible manufacturing system (FMS), FMS and its planning and implementation, automated assembly system – design and types of automated assembly systems, analysis of multi station and single station assembly machine

3 HYDRAULIC CONTROL SYSTEM

Hydraulic linear actuators, mechanics of hydraulic cylinder loading

Hydraulic Motors: Hydraulic rotary actuators, gear motors, vane motors, piston motors, hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance. Simple control of hydraulic systems

4 PNEUMATIC CONTROL SYSTEM

Choice of working medium characteristics of compressed air, structure of pneumatic control system. **Pneumatic Actuators:** Linear cylinders –types, conventional type of cylinder working, end position cushioning, seals, mounting arrangements applications **Simple Pneumatic Control**: Direct and indirect actuation of pneumatic cylinders, basic pneumatic valves, flow control valves and speed control of cylinders supply air throttling and exhaust air throttling, use of quick exhaust valve, pressure dependent controls types, time dependent controls

5 PROGRAMMABLE LOGIC CONTROLLERS

Programmable controllers, programmable logic controllers, analog digital input and output modules, PLC programming, ladder diagram, sequential flow chart, PLC communication and networking, PLC selection, PLC installation, advantage of using PLC for industrial automation, application of PLC to process control industries

6 OVERVIEW OF ADVANCED TECHNOLOGIES IN AUTOMATION

Applications of artificial intelligence; machine learning and deep learning in automation; digital manufacturing; smart manufacturing; IoT and cloud based manufacturing

TEXT/REFERENCE BOOKS:

1. Groover, M.P., 2001. Automation, production systems and computer-integrated manufacturing. 2nd edn. Prentice Hall.
2. Johnson, C.D., 2005. Process control instrumentation technology. 8th edn. Pearson New International / Prentice-Hall of India.
3. Webb, J.W. and Reis, R.A., 2003. Programmable logic controllers: principles and applications. 5th edn. Prentice Hall.
4. Petruzella, F.D., 2016. Programmable logic controllers. 5th edn. McGraw-Hill.
5. Srinivasan, R., 2004. Hydraulic and pneumatic controls. Vijay Nicole, India.
6. Parr, A., 2011. Hydraulics and pneumatics: a technician's and engineer's guide. 3rd edn. Butterworth-Heinemann.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1	Understand Basics of Automation, different levels of automation
CO2	Understand various automation tools and methods in the manufacturing industry
CO3	Evaluate different components of the hydraulic system and prepare a hydraulic circuit diagram.
CO4	Evaluate different components of the pneumatic system and prepare a pneumatic circuit diagram.
CO5	Learn various fundamentals about PLC and programming of PLC
CO6	Understand use of latest technologies in automated manufacturing.

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	0	0	0	0	0	1	0	2	1	1
CO2	2	2	2	0	0	0	0	0	1	0	2	1	1
CO3	2	2	2	0	1	0	0	0	1	0	2	2	2
CO4	2	2	2	0	1	0	0	0	1	0	2	2	2
CO5	2	1	2	0	1	0	0	0	1	0	2	2	2
CO6	2	1	2	0	1	0	0	0	1	0	2	2	2

1-Slightly; 2-Moderately; 3-Substantially

HONOR / MINOR – ROBOTICS AND AUTOMATION
SUBJECT: (ROB05) AUTOMATION, CONTROL AND PROGRAMMING LAB
(w.e.f. 2025-26)

Teaching Scheme (Hours)			Examination Scheme					Credit Structure			
Lect	Tut	Prac	Theory	Sess.	TW	Prac	Total	Lect	Tut	Prac	Total
0	0	6	0	0	50	50	100	0	0	3	3

DETAILED SYLLABUS:

Sr. No.	Contents
	AUTOMATION
1	Introduction to hydraulic system and components of hydraulic system.
2	Single rod cylinder Meter-in and Meter-out circuits using 4/2 DCV
3	Signal storage by means of electrical self-locking resetting by means of a proximity switch in hydraulic system
4	Introduction to pneumatic system and various parts of it.
5	Direct /Indirect control of double acting cylinder
6	Controlling a double acting cylinder using impulse valve and 2 push buttons.
7	Position dependent control of a double acting with mechanical limit switches
8	Sequential control of two double acting cylinders without overlapping signals
9	Basic circuit with AND /OR function
10	Sequential control of two double-acting cylinder with spring return valves and step sequence
11	Rotation of stepper Motor for Required Angle
12	PLC Controlled Material Handling System, Process Control using Virtual Instrumentation, Pick and place operation of Robot in Manual Mode
13	**CONTROL AND PROGRAMMING**
14	Analysis of a typical spring-mass-damper mathematical model of a mechanical system using LabVIEW.
15	Steering control of a mobile robot using LabVIEW
16	Simulation of Legged walking robots in MATLAB environment.
17	Characteristics of Inductive, capacitive and photoelectric proximity sensors
18	Operating a simple load using relays, switches and push buttons using PLC
19	Robot teaching using VAL II Programming, plan mobile robot paths using RRT in MATLAB, Control of a mobile robot using gesture in Python