DAV UNIVERSITY JALANDHAR

Course Scheme & Syllabus

For

PG Diploma in

Robotics

1st to 2nd semester Examinations 2021–2022 Session Onwards

Syllabi Applicable for Admissions in 2021 onwards

Post Graduate Diploma in Robotics (PGDR)

DAV UNIVERSITY, JALANDHAR

SEMESTER I

Sl. No.	Course Code	Course Title	Hours/Week			Credit Points
			L	T	P	
1	ECE581	Fundamentals of Computer Programming	3	1	0	4
2	MEC051	Introduction to Robotics	3	1	0	4
3	ECE582	Embedded system and Digital Signal Processing (DSP)	3	1	0	4
4	ECE583	Sensors and Actuators	3	1	0	4
5	ECE590	Seminar	0	0	3	2
6	MEC056	Robotics Automation Lab	0	0	3	2
7	ECE586	Fundamentals of Computer Programming Lab	0	0	3	2
8	ECE587	Sensors and Actuators Lab	0	0	3	2
9	ECE588	Robotics Lab-I	0	0	3	2
Semester Credit Points			**12**	**4**	**15**	**26**

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SEMESTER II

Sl. No.	Course Code	Course Title	Hours/Week			Credit Points
			L	T	P	
1	ECE584	Robot Control Systems	3	1	0	4
2	MEC052	Introduction to CAD, 3-D Modelling and Robot Mechanics	3	1	0	4
3	ECE589	Robotics Lab-II	0	0	3	2
4	ECE591	Robotic Case Studies	0	0	8	4
5	ECE592	Project Work and Viva-voce	0	2	16	10
Semester Credit Points			**6**	**4**	**27**	**24**

Program Total Credit Points	**50**

Detailed Syllabus

DAV UNIVERSITY, JALANDHAR

Course Code: ECE581

Course Title: FUNDAMENTALS OF COMPUTER PROGRAMMING & ROBOT PROGRAMMING

L-T-P-C: 3-1-0-4

Course Objectives:

This course offers a good understanding of Visual Programming concepts and prepares students to be in a position to write applications programs in C,Pearl,C++ and Python.

Learning Outcomes:

At the end of the course students will have thorough knowledge of fundamental concepts of C,Pearl,C++ and Python and its importance in real life.

Unit – A

C Language: Introduction, Operators, Conditional statements and loops, Arrays, Functions (Library functions, user defined function, passing arguments to a function, call by reference, call by value, recursive functions), Structures and Unions, Pointers.

Unit – B

Perl: Built in functions and user defined functions, Subroutines

C++: C++ Overview, Classes in C++, Overloading (operator overloading, function overloading), Inheritance (overview of inheritance, defining base and derived classes, constructor and destructor calls).

Unit – C

MATLAB: Matrix operations and functions in MATLAB, MATLAB scripts and functions (m-files) Simple sequential algorithms, Reading and writing data, file handling, Personalized functions, Toolbox structure, Random number generation, Interactive hands-on-session.

Unit – D

Python: Basics of Python, Operators and Expressions, Control flow, Functions, Modules, Problem Solving in python, Input and outputs in python.

References:

1. Herbert Schildt, *C : The Complete Reference, Fourth Edition*, McGraw Hill.
2. Dinesh Tavasalkar, *Hands-On Robotics Programming with C++*, Packt Publishing, 2019.
3. John V. Guttag, *Introduction to Computation and Programming Using Python*, Revised and expanded Edition, MIT Press, 2013

4. Peter Corke, *Robotics, Vision and Control: Fundamental Algorithms in MATLAB*, Springer, 2011

DAV UNIVERSITY, JALANDHAR

Course Title: Introduction to Robotics
Course Code: MEC051

L-T-P-C: 3-1-0-4

Objectives:

- To impart exposure to basic Robot Configurations, Sensors, Actuators.
- To impart knowledge about Programming & applications of Robots.

Learning Outcome:

- • Students will learn about the basic concepts of automation.
- • Students will learn about the robotics, about the robotics and its programming

UNIT-A

Introduction to Robotics: Introduction to Automation, Fixed, programmable and flexible automation, Robot Definition, Brief History, Evolution of Robots and Robotics, Laws of Robotics, Progressive advancement in Robots. Robot anatomy, Human Arm Characteristics, Classification of Robots on the basis of Configuration and other Aspects, Specifications of Robot Systems, Spatial Resolution, Accuracy, Repeatability, Robot Anatomy, Work Volume, Drive Systems, Power Transmission System, Joint Notation Scheme, Control Method of Teaching, Control Systems, Robot End Effectors, Mechanism of Operation, Mechanical and other Types of Grippers, Tools as End Effectors, End Effectors Interface.

UNIT –B

Robot Actuators and Sensors: Actuator and Drive Elements, Hydraulic, Pneumatic and Electrical Drives, Criteria for Selection of Drives, Sensors like Displacement, Proximity and Range Sensors, Touch, Force Sensors, Machine Vision etc, Robot cell layouts, Design of Work Cells and Control, Robot as a work cell controller, Use of Interlocks.

UNIT –C

Programming and Applications: Methods of Robot Programming, Lead through Programming, Motion Interpolation, Use of Branching, Textual Robot Languages, Structure, Motion Commands, Speed Control, End Effectors and Sensor Commands, Application of Robots in Industrial Environments such as in Assembly, Welding, Spray Painting, Machine Loading and Unloading etc.

UNIT –D

Coordinate Frames, Mapping and Transforms: Basics of vector algebra, Coordinate Frames, Mapping and Transformation, Rotation about points, axis, scaling, translation, homogeneous transformations etc. Inverting a Homogeneous Transform, Joint and link parameters of robot, Mechanical structure and its notations

References:

1. Deb, S.R., *Robotics Technology and flexible automation*, Tata McGraw-Hill Education., 2009
2. Groover, Mikell P., Odrey Nicholas G, Mitchel Weiss, Roger N Nagel, Dutta Ashish, *Industrial Robotics, Technology programming and Applications*, McGraw Hill, 2012
3. Klafter Richard D. R, A. Thomas, Elewski Chris, Negin, Michael, *Robotics Engineering an Integrated Approach*, Phi Learning., 2009.
4. Mittal and Nagrath, *Robotics and control*, , Tata McGraw Hill, 2010
5. Nagy, Francis N., Siegler, Andras, *Engineering foundation of Robotics*, Prentice Hall Inc., 1987

DAV UNIVERSITY, JALANDHAR

Course Title: EMBEDDED SYSTEM AND DIGITAL SIGNAL PROCESSING (DSP)

Course Code: ECE582

L-T-P-C: 3-1-0-4

Course Objective:

The purpose of this course is to introduce the concepts of Microcontrollers and Digital signal processing.

Learning Outcomes:

- At the end of this course students will demonstrate the ability to Represent signals mathematically in continuous and discrete time and frequency domain
- Get the response of an LTI system to different signals
- Design of different types of digital filters for various applications
- Do assembly language programming

UNIT –A

Introduction to Microcontrollers: Digital Electronics Fundamentals, Microcontroller, Basics of state machine, Assembly language programming.

UNIT –B

Programming of Microcontrollers: Embedded C programming, Algorithm development and its application specific system design with microcontroller and simulation.

UNIT –C

Introduction of Signal and Systems:Elements of Analog and Digital Signal Processing, Advantages of Digital over Analog. Discrete Time Signals & Systems – Classification, Analysis of LT Systems, of LTI system Response to Arbitrary Inputs, Causality, Stability, Correlation, Convolution .

UNIT –D

Fourier analysis:Analysis in Z-domain, Fourier Analysis – Continuous & Discrete-Time Fourier Series, Power Density Spectrum, Fourier Transform, Frequency-Domain Characteristics of LTI Systems, DFT & Properties, Fast Fourier Transforms (FFT), Digital Filter Design and applications.

References:

1. S.K. Mitra, Digital Signal Processing: A computer-based approach. TMH

2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, Latest Edition.

3. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall, Latest Edition.

4. L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall, Latest Edition.

5. J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, Latest Edition.

6. D.J.DeFatta, J. G. Lucas andW.S.Hodgkiss, Digital Signal Processing, John Wiley& Sons, Latest Edition.

7. Gaonkar, Ramesh. 8085 Microprocessor. PHI Publications.

8. Mazidi, Muhammad Ali. & Mazidi, Janice Gillispie. The 8051 Microcontroller and Embedded systems. Pearson Education. 2004. 7th Edition,.

9. Doughlas.V.Hall. Microprocessor and Interfacing Programming and Hardware. McGraw Hill. 1992. Revised 2nd edition.

10. Steve, Furbe., ARM System on Chip Architecture. Pearson Education. 2000. Second Edition,

11. D A Patterson and J H Hennessy, "Computer Organization and Design The hardware and software interface" Morgan Kaufman Publishers.

12. Kenneth J. Ayala, The 8051 Microcontroller, Penram International Publishing, 1996.

DAV UNIVERSITY, JALANDHAR

Course Title: SENSORS AND ACTUATORS

Course Code: ECE583

L-T-P-C : 3-1-0-4

Course Objective:

To impart knowledge on various types of sensors andActuators, for the automation in science, engineering and medicine.

Learning outcomes: The study of this course will lead to Understanding

- the basic concepts of various sensors andActuators.
- Develop knowledge in selection of suitable sensors based on requirement and application.

UNIT –A

Fundamentals of sensor and Transducer: Various sensing principle, Resistive sensing element: potentiometer, resistance thermometer, strain gauge. capacitive sensing elements: variable separation, area and dielectric, Inductive sensing elements: variable reluctance and LVDT, RVDT displacement.

UNIT –B

Fundamentals of electromechanical Sensors: Electrometric sensing elements: velocity, techo, elastic sensing element: force, torque, acceleration, pressure, gyroscope, optical sensor, strain gauge based force-torque sensors proximity and distance measuring sensors, and vision.

UNIT –C

Fundamentals of Actuators:Principle of actuator, type of actuators, mechanical actuator, electrical actuator, hydraulic actuator, Pneumatic actuator and other different kinds of actuators .

UNIT –D

Fundamentals of Motors: Stepper, DC servo and brushless motors, model of a DC servo motor, Smart Material based actuator like Electro active polymer (EAP), ionic polymer metal composite (IPMC), piezoelectric and shape memory alloy actuator etc and its application in robotics.

References:

1. Patranabis, D. Sensor and Actuators. Prentice Hall of India (Pvt) Ltd., 2006.

2. Ian Sinclair. Sensor and Transducers. Elsevier India Pvt Ltd, 2011, 3rd Edtion.

3. Sawhney.A.K, Puneeth sawhney. A Course in Electrical and Electronic Measurements and Instrumentation. Dhanpat Rai Publications, 2012.

4. Ernest O. Doeblin. Measurement System, Application and Design. Tata McGraw Hill Publishing Company Ltd., 2008, 5th Edition.

DAV UNIVERSITY, JALANDHAR

Course Title: SEMINAR

Course Code: ECE590

L-T-P-C : 0-0-3-2

Students have to deliver seminar on the latest advancements in Robotics and Robotics applications.

DAV UNIVERSITY, JALANDHAR

Course Title: INTRODUCTION TO 3-D MODELLING AND ROBOT MECHANICS

Course Code: MEC052

L-T-P-C: 3-1-0-4

Objectives:

- To provide the basic analytical fundamentals those are used to create and manipulate geometric models in a computer program.
- To impart knowledge about Kinematics and Manipulator Differential Motion.

Learning Outcomes:

- Students will be able to describe the principles of Computer Aided Designing systems and the concepts of Geometric transformations and modelling

Unit-A

Fundamentals of CAD

Introduction, Design Process, Application of computers in design, Creating manufacturing database, benefits of CAD, Software configuration of a graphics system, functions of a graphics package, geometric modeling, Fundamentals of Computer Graphics.

Geometric Transformations

Mathematics preliminaries, matrix representation of 2- and 3-dimensional transformation, Concatenation of transformation matrices, Application of geometric transformations.

UNIT-B

Geometric Modelling

Need of Geometric Modelling, types of geometric modelling, geometric modelling representation, and geometric modelling techniques and uses, parametric representation of analytical and synthetic curves, parametric representation of surfaces, Coons and bicubic. Patches, Solid modelling, CSG.

UNIT-C

Kinematics

Forward kinematics of Robots, Kinematic modelling of the manipulator, Manipulator Transformation Matrix, D-H Algorithm, Solution of Problems using D-H Algorithm,

Introduction to inverse Kinematics, Manipulator workspace, solvability of Inverse kinematics model, solution techniques, closed form solution. Uniqueness of Solutions, Solutions Techniques

UNIT-D

Manipulator Differential Motion and Statics and Dynamics

Linear and angular velocity of a rigid body, relationship between transformation matrix and angular velocity, manipulator Jacobian, Jacobian Inverse, Jacobian Singularities, Static Analysis. Largrangian Mechanics, Two Degree of Freedom manipulator-Dynamic Model.

References:

1. Groover and Zimmer. *CAD/ CAM.* Prentice Hall. Print. 2010.
2. Zeid, I. *CAD/ CAM Theory and Practice.* McGraw Hill. 2009
3. Bedworth, D.D., Henderson, M.R. & Wolfe, P.M. *Computer Integrated Design and Manufacturing*. New Delhi: Tata McGraw Hill. 1991
4. W. M. Neumann and R.F. Sproul, *Principles of Computer Graphics*, McGraw Hill, 1989.
5. Mikell P. Groover, *Automation, Production Systems, and Computer-integrated Manufacturing*, prentice Hall, 2007
6. YoramKoren, *Computer control of manufacturing system*, 1st edition, 2005
7. Rogers, D. and Edams, *Mathematical Elements For Computer Graphics*, Mc Graw Hill, 2017.
8. Asfahl, C.R. *Robotics and Manufacturing Automation.* Wiley India. 1992. Print.
9. Niku, S.B. *Introduction to Robotic Analysis systems and applications.* Wiley India. 2001. Print.
10. http://nptel.ac.in/courses/112102102/112102103

DAV UNIVERSITY, JALANDHAR

Course Title: Robotics and Automation Lab

Course Code: MEC056 **L-T-P-C: 0-0-3-2**

List of Experiments:

1. Study of robotic arm and its configuration.
2. Study the robotic end effectors.
3. Study of different types of hydraulic and pneumatic valves.
4. Study of reciprocating movement of double acting cylinders using pneumatic directional control valves.
5. Use of direction control valve and pressure control valves clamping devices for jig and fixture.
6. Design and assembly of meter in and out circuits.
7. Design and assembly of pneumatic regenerative circuit.
8. Design and assembly of pneumatic circuits for sequence operation.

DAV UNIVERSITY, JALANDHAR

Course Code: ECE586

Course Title: FUNDAMENTALS OF COMPUTER PROGRAMMING LABORATORY

L-T-P-C: 0-0-3-2

List of Experiments

1. Program in C to learn and demonstrate basic programming constructs, functions, conditional statements, loops, call-by-value/reference.
2. Demonstrate port programming in C, serial/parallel ports, USB ports
3. Demonstrate the use of unions and structures in C
4. Demonstrating file system utilities in Perl scripts
5. Use of functions, command-line arguments in Perl scripting
6. Interaction of objects and inheritance in C++
7. Writing modular and encapsulated object-oriented device I/O
8. Study of various signals using MATLAB
9. Study system responses using MATLAB
10. Writing Python scripts to read and write files
11. Write Python program using command-line arguments
12. Writing Python scripts for cross application integration and automation

DAV UNIVERSITY, JALANDHAR

Course Code: ECE588

Course Title: ROBOTICS LAB- I

L-T-P-C: 0-0-3-2

Experiments:

1. Electric Motors interfacing and control
    a. Brushed / Brushless DC motors in portable robots
    b. Servo/Stepper motors for pick and drop applications
    c. AC motors in industrial robots / CNC Machines

2. Microcontrollers and interfacing
    a. Program load/store in high endurance NVM segments
    b. Peripheral features
    c. Communication protocols
    d. Operating voltage and voltage stabilization
    e. Performing autonomous motion with a robot assembly

3. Autonomous Robots
    a. Line-following robots
    b. Obstacle avoiding robots
    c. Wireless controlled robots
    d. Android controlled robots

DAV UNIVERSITY, JALANDHAR

Course Title: ROBOT CONTROL SYSTEMS

Course Code: ECE584

L-T-P-C : 3-1-0-4

Course Objective:

This course provides a comprehensive understanding of the introductory concept of control systems. and It traces the evolution of controller thought from its earliest days to the present, by examining the backgrounds, ideas and influences of its major contributors.

Learning Outcomes:

After the completion of this course the participants would gain the knowledge of the servomechanism, regulating systems, open and closed loop control systems . The course will equip them with the understanding of the concepts of time domain, and frequency domain analysis.

UNIT-A

Introduction: Control Principles, Control Objectives, Modelling of Physical systems, Principles of Linear Control-Stability aspects, Root locus technique.

UNIT-B

Frequency response analysis: Bode Plot, Design of PID Controller, Controller tuning.

UNIT-C

State Space Design: Concepts of state, State-space, Representation of Linear system, Controllability and Observability, Stabilizability and Detectability, Observer design, Linear Kalman Filters.

UNIT-D

Notion of Nonlinear Control, Basics of Nonlinear Control, Nonlinear Control Methods: Feedback Linearization (Input-state & Input-output linearization); Concepts of Lyapunov Stability and analysis, Sliding Mode Control.

References:

1. Nagrath I.J. and Gopal M., "Control System Engineering", Wiley Eastern Ltd

2. Ogata K., "Modern Control Engineering", Prentice Hall

3. Kuo B. C., "Automatic Control System", Prentice Hall

4. Dorf Richard C. and Bishop Robert H., "Modern Control System", Addison –Wesley, Pearson New Delhi

DAV UNIVERSITY, JALANDHAR

Course Title: ROBOTIC CASE STUDIES

Course Code: ECE591

L-T-P-C : 0-1-8-5

Different robotic systems case studies and its implementation in on-going projects

Utility of robotic systems in Industry.

DAV UNIVERSITY, JALANDHAR

Course Title: Robotics Lab II

Course Code:ECE589 **L-T-P-C: 0-0-3-2**

List of Experiments:

Robotic based application like

1. Palletizing using blocks or other components
2. Small assembly
3. Drawing task using pen or marker
4. Pick and place application
5. Inspection Additional Applications
6. Soldering with a suitable end effector
7. Touch screen testing
8. Vision based picking, assembly, inspection
9. Drilling (Using drilling tool as end effector)
10. Colour sorting

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Course Title: Sensors and Actuator Lab

Course Code: ECE587 **L-T-P-C: 0-0-3-2**

List of Experiments:

1. To study the digital response of an IR motion sensor and to determine its range.

2. To design a motion sensitive intruder alarming system using IR motion sensor.

3. To measure the distance of an object using the SONAR principle by ultrasonic proximity sensor and determine the accuracy of the instrument.

4. To study the operation of a digital humidity sensor and calculate the accuracy of the device.

5. To study and measure Temperature using RTD.

6. To study and measure Temperature using Thermistor

7. To study and measure Temperature using Thermocouple.

8. To measure the level in the tank using a capacitive sensor.

9. To characterize LVDT and measure displacement using LVDT.

10. To characterize Strain Gauge and application as load cell.

11. Study of DC, AC, Stepper, Induction motors, solenoid type and electromagnetic relays.

12. Study of control valves and piezoelectric actuators.

DAV UNIVERSITY, JALANDHAR

Course Title: Project Work and Viva-voce

Course Code: ECE592 **L-T-P-C: 0-2-16-10**

Student hasto design practical project on robotics on the basis of the knowledge gained from the curriculum and deliver a presentation and submit a report for the same.