VEER MADHO SINGH BHANDARI
UTTARAKHAND TECHNICAL UNIVERSITY DEHRADUN

Specialization/Minor in Robotics Engineering

EFFECTIVE FOR 2021-22 BATCH

2ND YEAR TO 4TH YEAR

Eligible Branches to adopt as Specialization

1. **B.Tech.- Mechanical Engineering**
2. **B.Tech.- Electronics and Communication Engineering**
3. **B.Tech.- Electronics Engineering**

Evaluation Schemes for Specializations/Minor in B.Tech

Specialization in Robotics Engineering										
S.No.	**Code**	**Sem**	**Subject**	**Periods**			**Evaluation Scheme**		**Total Marks**	**Credits**
				L	T	P	**Internal**	**External**		
1.	SRE301	3rd	Robotics & Control	3	0	0	50	100	150	3
2.	SRE401	4th	Robotic Engineering	3	0	0	50	100	150	3
3.	SRE501	5th	Introduction to Artificial Intelligence	3	0	0	50	100	150	3
4.	SRE601	6th	Machine Learning	3	0	0	50	100	150	3
5.	SRE701	7th	Computer Programming in Python	3	0	0	50	100	150	3
6.	SRE801	8th	Embedded System Design	3	0	0	50	100	150	3
				18	**0**	**0**	**300**	**600**	**900**	**18**

SRE301	ROBOTICS & CONTROL	L	T	P	C
		3	0	0	3

Contents		Hours
Unit 1	UNIT I Introduction: Definition, automation principles and strategies, scope of automation, socio-economic consideration, low cost automation, basic elements of advanced functions, Information processing in manufacturing industry, Production concepts and automation strategies. Fixed Automation: Automated Flow lines, Methods of Work part Transport, Transfer Mechanism - Continuous transfer, intermittent transfer, Indexing mechanism, Operator-Paced Free Transfer Machine, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations.	8
Unit 2	Assembly Systems and Line Balancing: The Assembly Process, Assembly Systems, Manual Assembly Lines, The Line Balancing Problem, Methods of Line Balancing, Computerized Line Balancing Methods, Other ways to improve the Line Balancing, Flexible Manual Assembly Lines. Automated Assembly Systems: Design for Automated Assembly, Types of Automated Assembly Systems, Vibratory bowl feeder and Non vibratory bowl feeder, Part Orienting Systems, Feed tracks, Escapements and part placing mechanism, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine.	12
Unit 3	Automated Materials Handling: The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Carousel Storage Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. [	8
Unit 4	Introduction to control and Feedback Control: Basic principles, Elements of the feedback Loop, Block Diagram, Control Performance, Measures for Common Input Changes, Selection of Variables for Control Approach to Process Control. Factors in Controller Tuning, Determining Tuning Constants for Good Control Performance, Correlations for tuning Constants, Fine Tuning of the controller tuning Constants. The performance of feedback Systems, Practical Application of Feedback Control: Equipment Specification, Input Processing, Feedback Control Algorithm, Output Processing.	8
Unit 5	Multi Loop & Nonlinear Systems: Cascade control, Feed forward control, feedback-feed forward control, Ratio control, Selective Control , Split range control- Basic principles, Design Criteria , Performance, Controller Algorithm and Tuning, Implementation issues, Examples and any special features of the individual loop and industrial applications. Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance, Improvement in nonlinear process performance through: Deterministic Control Loop Calculations, Calculations of the measured variable, final control element selection, cascade control design, Real time implementation issues.	9

Text Books:

1. MikellP.Grover, “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education Asia, 2001.
2. C.RayAsfahl, “Robots and manufacturing Automation”, John Wiley and Sons New York, 1992.
3. N.Viswanadham and Y.Narahari, “Performance Modeling of Automated Manufacturing Systems”, Prentice Hall India Pvt. Ltd, 1992.
4. K. Ogata, “Modern control engineering”, Pearson 2002.
5. NagraathGopal “Control Systems Engineering -Principles and Design” New Age Publishers.

SRE401	ROBOTIC ENGINEERING	L	T	P	C
		3	0	0	3

Contents		Hours
Unit 1	Introduction History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology-Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot.	8
Unit 2	Drive systems and Sensors Drive system- hydraulic, pneumatic and electric systems Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure sensors.	10
Unit 3	Kinematics and Dynamics of Robots 2D, 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformation, Simple problems. Matrix representation, Forward and Reverse Kinematics Of Three Degree of Freedom, Homogeneious Transformations, Inverse kinematics of Robot,Robot Arm dynamics, D-H representationof robots, Basics of Trajectory Planning.	8
Unit 4	Robot Control, Programming and Applications Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT,Motion Interpolations, Adaptive control. Introduction to Robotic Programming, On-line and off-line programming, programming examples.	10
Unit 5	Robot applications-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting.	9

Text Books:

1. S.R. Deb, “Robotics Technology and flexible automation”, Tata McGraw-Hill Education., 2009.
2. Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning., 2009.
3. Francis N. Nagy, AndrasSiegler, "Engineering foundation of Robotics", Prentice Hall Inc., 1987.
4. P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.
5. Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University press, 2008.
6. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., “Robotics control, sensing, vision and intelligence”, McGraw Hill Book co, 1987
7. Ray Asfahl. C., “Robots and Manufacturing Automation”, John Wiley & Sons Inc.,1985

SRE501	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

Contents		Hours
Unit 1	**Overview**: foundations, scope, problems, and approaches of AI. **Intelligent agents**: reactive, deliberative, goal-driven, utility-driven, and learning agents. **Problem-solving through Search**: forward and backward, state-space, blind, heuristic, problemreduction, A, A*, AO*, mini-max, constraint propagation, neural, stochastic, and evolutionary search algorithms, sample applications.	8
Unit 2	**Knowledge Representation and Reasoning**: ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications. **Planning**: planning as search, partial order planning, construction and use of planning graphs	12
Unit 3	**Representing and Reasoning with Uncertain Knowledge**: probability, connection to logic, independence, Bayes rule, Bayesian networks, probabilistic inference, sample applications. **Decision-Making**: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications.	8
Unit 4	**Machine Learning and Knowledge Acquisition**: learning from memorization, examples, explanation, and exploration. Learning nearest neighbour, naive Bayes, and decision tree classifiers, Q-learning for learning action policies, applications.	8
Unit 5	**Languages for AI problem solving**: Introduction to PROLOG syntax and data structures, representing objects and relationships, built-in predicates. Introduction to LISP- Basic and intermediate LISP programming. **Expert Systems**: Architecture of an expert system, existing expert systems like MYCIN, RI, Expert system shells.	9

Text Books:

1. Rich E., Artificial Intelligence, Tata McGraw Hills (2009).
2. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education Asia (2009).
3. Patterson D.W, Introduction to AI and Expert Systems, McGrawHill (1998).
4. ShivaniGoel, Express Learning- Artificial Intelligence, Pearson Education India(2013).

SRE601	MACHINE LEARNING	L	T	P	C
		3	0	0	3

Contents		Hours
Unit 1	**Introduction:** well posed learning problem, designing a learning system: training experience, target function, final design. Issues in machine learning Concept, Learning and General to specific ordering: concept learning task, concept learning as search, version spaces and candidate elimination, inductive bias.	10
Unit 2	**Decision Tree learning (DTL)**: introduction, decision tree representation, problems for DTL, DTL algorithm, hypothesis space search, inductive bias in DTL, issues in DTL. Bayesian Learning: Introduction, Bayes Theorem, concept learning, least square hypothesis, predicting probabilities, Bayes optimal classifiers, EM algorithm.	12
Unit 3	**Instance Based Learning**: introduction, K-nearest neighbor learning, locally weighted regression, case based reasoning. Learning set of rule: introduction, sequential covering algorithm, learning rule sets, first order rules.	14
Unit 4	**Analytical learning**: introduction, perfect domain theory, explanation based learning. Inductive analytical approaches to learning.	9

Text Books:

1. Tom M. Mitchell , "Machine learning", McGraw Hill 1997.
2. EthemAlpaydin, "Introduction to machine learning", PHI learning, 2008.
3. RajjanShinghal, "Pattern Recognition", Oxford Press, 2006.
4. Duda, Hart and Stork, "Pattern Classification", 2000.
5. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning", Springer 2001.

SRE701	COMPUTER PROGRAMMING IN PYTHON	L	T	P	C
		3	0	0	3

Contents		Hours
Unit 1	Introduction to Python Programming Language. : Introduction to Python Language, Strengths and Weaknesses, IDLE, Dynamic Types, Naming Conventions, String Values, String Operations, String Slices, String Operators, Numeric Data Types, Conversions, Built In Functions	8
Unit 2	Data Collections and Language Component : Introduction, Control Flow and Syntax, Indenting, The if Statement, Relational Operators, Logical, Operators, True or False, Bit Wise Operators, The while Loop, break and continue, The for Loop, Lists, Tuples, Sets, Dictionaries, Sorting Dictionaries, Copying Collections	12
Unit 3	Object and Classes : Classes in Python, Principles of Object Orientation, Creating Classes, Instance Methods, File Organization, Special Methods, Class Variables, Inheritance, Polymorphism, Type Identification, Custom Exception Classes	8
Unit 4	Functions and Modules : Introduction, Defining Your Own Functions, Parameters, Function Documentation, Keyword and Optional Parameters, Passing Collections to a Function, Variable Number of Arguments, Scope, Functions - "First Class Citizens", Passing Functions to a Function, Mapping Functions in a Dictionary, Lambda, Modules	8
Unit 5	I/O and Error Handling In Python : Introduction, Data Streams, Creating Your Own Data Streams, Access Modes, Writing Data to a File, Reading Data From a File, Additional File Methods, Using Pipes as Data Streams, Handling IO Exceptions, Working with Directories, Metadata, Errors, Run Time Errors, The Exception Model, Exception Hierarchy, Handling Multiple Exceptions	9

Text Books:

1. Dive into Python, Mike
2. Learning Python, 4th Edition by Mark Lutz
3. Programming Python, 4th Edition by Mark Lutz

SRE801	EMBEDDED SYSTEM DESIGN	L	T	P	C
		3	0	0	3

Contents		Hours
Unit 1	Introduction to Embedded System Design,Categories of ES,Overview of Embedded System Architecture, Recent Trends in Embedded Systems, Hardware Architecture of Embedded System,Real-time Embedded Systems and Robots, Robots and Robotics, Microprocessors and Microcontrollers, Microcontroller or Embedded Controller	8
Unit 2	Robotics: Classification of Robots, Degree of freedom, Kinematics; Multidisciplinary approach: Motors-DC motors, Stepper Motors, Servo Motors; Power Transmission-Type of Gears, Gear Assembly, CAM follower, Sensors, Open- loop and Closed-loop Controls, Architecture of 8051 Microcontroller-Assembly language programming (data types, directives, flag bits, PSW, register banks and Stacks)	12
Unit 3	Jump, Loop and Call instruction, Time delay for various 9051 chip, I/O programming and I/O bit manipulation, Interface of LED module, Key Scanning Case studies to design sensor(LDR),Motor Driver(H-bridge)module	8
Unit 4	Case studies of Closed-loop control and a learning robot-Hardware requirement, Locomotion and obstruction sensing, Learning process, Picking another set of points Addressing Modes of 8051,Power Management of 8051,Timer Interrupts, Multiplexed displays Case studies to Design an Intelligent Clock	8

Text Books:

1. Subrata Ghoshal,"Embedded Systems & Robots", engage Learning
2. M.A.Mazidi, J.G.Mazidi, R.D.Mckinlay,"8051MicrocontrollerandEmbeddedSystems",Pearson.
3. Dr.K.V.K.Prasad,"Embedded/Real-TimeSystems:ConceptsDesign&Programming",Dreamtech