



**KALINGA
UNIVERSITY**

SCHEME & SYLLABUS FOR

Bachelor of Vocational Studies (B.Voc.) Robotics



Kalinga University, Naya Raipur, Chhattisgarh

SCHEME FOR BACHELOR OF VOCATIONAL STUDIES (ROBOTICS)

Semester - 01								
Course Code	Course Title	Credits	L	T	P	Internal Marks	End Semester Exam Marks	Total Marks
BVR101	Communication Skills	3	3	0	0	30	70	100
BVR102	Fundamentals of Information Technology	3	3	0	0	30	70	100
BVR103	Introduction to Robotics	3	3	0	0	30	70	100
BVR104	Basics of Electronics and Electrical Systems	3	3	0	0	30	70	100
BVR105P	Industrial Training/On Job Training/Workshop	18	0	0	36	50	150	200
Total		30	12	0	36	170	430	600

Semester - 02								
Course Code	Course Title	Credits	L	T	P	Internal Marks	End Semester Exam Marks	Total Marks
BVR201	Fundamentals of Artificial Intelligence	3	3	0	0	30	70	100
BVR202	Environmental Studies	3	3	0	0	30	70	100
BVR203	Applied Mathematics	3	3	0	0	30	70	100
BVR204	Basics of Mechanical Systems	3	3	0	0	30	70	100
BVR205P	Industrial Training/On Job Training/Workshop	18	0	0	36	50	150	200
Total		30	12	0	36	170	430	600

Semester - 03								
Course Code	Course Title	Credits	L	T	P	Internal Marks	End Semester Exam Marks	Total Marks
BVR301	Automatic Control System	3	3	0	0	30	70	100
BVR302	Fundamental of Mechatronics	3	3	0	0	30	70	100
BVR303	Principles of Robotics	3	3	0	0	30	70	100
BVR304	Industrial Safety Practices	3	3	0	0	30	70	100
BVR305P	Industrial Training/On Job Training/Workshop	18	0	0	36	50	150	200
Total		30	12	0	36	170	430	600

Semester - 04								
Course Code	Course Title	Credits	L	T	P	Internal Marks	End Semester Exam Marks	Total Marks
BVR401	Cyber Security Tools Techniques and Counter Measures	3	3	0	0	30	70	100
BVR402	Kinematics and Dynamics of Robotics	3	3	0	0	30	70	100
BVR403	Robotic Control Systems	3	3	0	0	30	70	100
BVR404	Programming for Robotics	3	3	0	0	30	70	100
BVR405P	Industrial Training/On Job Training/Workshop	18	0	0	36	50	150	200
Total		30	12	0	36	170	430	600

Semester - 05								
Course Code	Course Title	Credits	L	T	P	Internal Marks	End Semester Exam Marks	Total Marks
BVR501	IOT & Embedded Systems	3	3	0	0	30	70	100
BVR502	Sensors and Actuators for Robotics	3	3	0	0	30	70	100
BVR503	Robot Safety and Maintenance	3	3	0	0	30	70	100
BVR504	Robot System Design and SLAM (Simultaneous Localization and Area Mapping)	3	3	0	0	30	70	100
BVR505P	Industrial Training/On Job Training/Workshop	18	0	0	36	50	150	200
Total		30	12	0	36	170	430	600

Semester - 06								
Course Code	Course Title	Credits	L	T	P	Internal Marks	End Semester Exam Marks	Total Marks
BVR601	Industrial Robotics and Material Handling System	3	3	0	0	30	70	100
BVR602	Hydraulic and Pneumatic Drives for Robots	3	3	0	0	30	70	100
BVR603	Robotics for Industrial Automation	3	3	0	0	30	70	100
BVR604	Artificial Intelligence for Robotics	3	3	0	0	30	70	100
BVR605P	Industrial Training/On Job Training/Workshop	18	0	0	36	50	150	200
Total		30	12	0	36	170	430	600

Program Outcomes:

- **PO1.** Ability to apply fundamental knowledge of the specific skill-based trade for the solution of target skill sector.
- **PO2.** Ability to identify industry related problems at varied complexity and analyze the same to formulate/ develop substantiated conclusion using first principles of domain sectors and technical literature.
- **PO3.** Ability to design/ develop solutions for broad based problems in the target skill-based trade to address changing challenges put forward by market demand/ stakeholder.
- **PO4.** Ability to design and conduct technology enabled experiments, analyze the resulting data and interpret the same to provide valid conclusions.
- **PO5.** Ability to use the techniques, skills and modern tools that are necessary for skill-based trade to practice with clear understanding of limitations.
- **PO6.** Ability to apply broad understanding of ethical and professional skill-based trade practice in the context of global, economic, environmental and societal realities while encompassing relevant contemporary issues.
- **PO7.** Ability to apply broad understanding of impact of skill-based trade in a global, economic, environmental and societal context.
- **PO8.** Ability to develop practical solutions for skill trade problems within positive professional and ethical boundaries.
- **PO9.** Function effectively as a leader and as well as team member in diverse/multidisciplinary environments.
- **PO10.** Ability to communicate effectively in oral and written format addressing specific professional/ social demands.
- **PO11.** Ability to demonstrate knowledge and understanding of the first principles of skill trade and apply these to one's own work as a member and leader in a team, to complete project in any environment.
- **PO12.** Ability to recognize the need for and have the ability to acquire advance knowledge for addressing the changing technological demands of the target skill trade.

Program Specific Outcomes (PSO):

- Apply basic and fundamental knowledge of electronics, electrical, mechatronics fundamentals and Industrial automation specialization for the solution of robot manufacturing and process related problems.
- Identify complex industrial automation related problems at varied complexity and analyze the same to formulate/ develop substantiated conclusion using first principles of robotics, electronics, electrical and mechatronics and technical literature.
- Design and conduct technology enabled experiments, analyze the resulting data and interpret the same to provide valid conclusions.
- Use the techniques, skills and modern tools necessary for industrial robotics practice clear understanding of limitations.

SEMESTER - 01

BVR101

COMMUNICATION SKILLS

Course Objective:

- The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions. One of the critical links among human beings and an important thread that binds society together is the ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal. In the context of rapid globalization and increasing recognition of social and cultural pluralities, the significance of clear and effective communication has substantially enhanced.

Course outcomes:

- The purpose of this course is to introduce students to the theory, fundamentals and tools of communication
- To develop vital communication skills which should be integral to personal, social and professional interactions.
- One of the critical links between human beings.
- An important thread that binds society together is the ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal.
- In the context of rapid globalization and increasing recognition of social and cultural pluralities, the significance of clear and effective communication has substantially enhanced.

Unit - 1

06

- **Introduction:** Theory of communication, types and modes of communication, mediums and channels of communication, barriers to communication, English as a global language, the lingua franca, social influences on English

Unit - 2

06

- **Language of Communication:** Verbal and non-verbal (spoken and written) personal, social and business barriers and strategies intra-personal, inter-personal and group communication, varieties of English, language, accent, dialect, colloquialism, historical influences on English

Unit - 3

06

- **Speaking Skills:** Monologue dialogue group discussion effective communication/miscommunication interview public speech, regional influences on English, convergence and divergence, linguistic imperialism

Unit - 4

06

- **Reading and Understanding** Close reading, reading analysis of a text - audience and purpose, content and theme, tone and mood, stylistic devices, structure comprehension- analysis and interpretation translation (from Indian language to English and vice-versa) literary/knowledge texts

Unit - 5

06

- **Writing Skills:** Documenting report writing making notes letter writing, writing tabloids, diary entry, open letters, essays, newsletter and magazine articles, skits, short stories, impersonating characters it will enhance language of communication, various speaking skills such as personal communication, social interactions and communication in professional situations such as interviews, group discussions and office environments, important reading skills as well as writing skills such as report writing, note taking etc. while, to an extent, the art of communication is natural to all living beings, in today's world of complexities, it has also acquired some elements of science. it is hoped that after studying this course, students will find a difference in their personal and professional interactions.

References:

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr. Ranjana Kaul, Dr. Brati Biswas

BVR102

FUNDAMENTALS OF INFORMATION TECHNOLOGY

Course objective:

- This is a basic course for commerce students to familiarize with computer and its applications in the relevant fields and exposes them to other related courses of IT.

Course Outcomes:

- Gain a foundational understanding of key IT concepts, including hardware, software, and networks.
- Develop proficiency in using common computer applications, such as word processing and spreadsheet software.
- Explore the ethical and security considerations in IT, emphasizing responsible digital behavior.
- Acquire problem-solving skills by applying IT knowledge to real world scenarios.
- Prepare for further studies in IT or related fields by establishing a strong IT knowledge base.

Unit - 1

06

- **Computer characteristics:** Speed, storage, accuracy, diligence; digital signals, binary system, ASCII; historic evolution of computers
- **Classification of computers:** microcomputer, minicomputer, mainframes, supercomputers
- **Personal computers:** desktop, laptops, palmtop, tablet; hardware & software; von Neumann model.

Unit - 2

06

- **Hardware:** CPU, memory, input devices, output devices.
- **Memory units:** RAM (SDRAM, DDR RAM, RDRAM etc. feature wise comparison only); ROM different types: Flash memory;
- **Auxiliary storage:** Magnetic devices, optical devices; floppy, hard disk, memory stick, CD, DVD, CD/DVD-Writer;
- **Input devices** - keyboard, mouse, scanner, speech input devices, digital camera, touch screen voice input, joystick, optical readers, bar code reader;
- **Output devices:** Display device, size and resolution; CRT, LCD, LED;
- **Printers:** Dot-matrix, inkjet, laser; plotters, sound cards & speaker.

Unit - 3

06

- **Software:** System software, application software; concepts of files and folders, introduction to operating systems, different types of operating systems: single user, multitasking, time-sharing multi-user; booting, POST;
- **Basic features of two GUI operating systems:** Windows & Linux (Basic desk top management); Programming Languages, Compiler, Interpreter, Databases;
- **Application software:** Generic features of word processors, spread sheets and presentation software; generic introduction to latex for scientific typesetting; utilities and their use; computer viruses & protection, free software, open source.

Unit - 4

06

- **Computer Networks and Internet:** Connecting computers, requirements for a network: server, workstation, switch, router, network operating systems; internet: brief history, world wide web, websites, URL, browsers, search engines, search tips; internet connections: isp, dial-up, cable modem, well, dsl, leased line wireless and Wi-Fi connectivity ; email, email software features (send receive, filter, attach, forward, copy, blind copy); characteristics of web-based systems, web pages, web programming languages.

Unit - 5

06

- **Information Technology and Society:** Indian IT Act, intellectual property rights, issues. application of information technology in railways, airlines, banking, insurance, inventory control, financial systems, hotel management, education, video games, telephone exchanges, mobile phones, information kiosks, special effects in movies.
- **Programming Concepts & Techniques:** Program concept, characteristics of programme, stages in program development, tips for program designing, programming aids, algorithms, pseudo code, notations, design, flowcharts, symbols, rules, compiler & interpreter. introduction to programming techniques, top-down & bottom-up approach, unstructured, & modular programming, cohesion, coupling, debugging, syntax & logical errors, linking and loading, testing and debugging, documentation.

References:

1. Programming in C, R.S. Salaria, Khanna Publishing House
2. Computer Concepts and Programming in C, R.S. Salaria, Khanna Publishing House
3. Handbook of Computer Fundamentals, N.S. Gill, Khanna Publishing House

BVR103

INTRODUCTION TO ROBOTICS

Course Objective:

- To identify robots and its peripherals for satisfactory operation and control of robots for industrial and non-industrial applications

Course Outcomes:

On completion this course, students will be able to

- List and explain the basic elements of industrial robots.
- Analyze robot kinematics and its control methods.
- Classify the various sensors used in robots for better performance.
- Summarize various industrial and non-industrial applications of robots.

Unit - 1

08

- **Robot** - Basic concepts, Need, Law, History, Anatomy, specifications; Robot configurations-cartesian, cylinder, polar and articulate. Robot wrist mechanism, Precision and accuracy of robot

Unit - 2

08

- **End effectors** - Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types, Position and velocity feedback devices-Robot joints and inks-Types, Motion interpolation.

Unit - 3

07

- **Sensors in robot** - Touch sensors-Tactile sensor – Proximity and range sensors. Force sensor-Light sensors, Pressure sensors, Introduction to Machine Vision and Artificial Intelligence.

Unit - 4

07

- Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, Disaster management. Applications, Micro and Nanorobots, Future Applications.

References:

1. Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, "Industrial Robotics Technology, Programming and Applications", Tata –McGraw Hill Pub. Co., 2008.
2. Deb. S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.
3. Klafter. R.D, Chmielewski.T.A, and Noggin's., "Robot Engineering: An Integrated Approach", Prentice Hall of India Pvt. Ltd., 1994.
4. Fu. K.S, Gonzalez. R.C & Lee. C.S.G, "Robotics control, sensing, vision and intelligence", Tata McGraw Hill Pub. Co., 2008
5. Yu. "Industrial Robotics", MIR Publishers Moscow, 1985.

BVR104

BASICS OF ELECTRONICS AND ELECTRICAL SYSTEMS

Course Objective:

- The main objective of this course is to understand the basics knowledge on electrical and electronics systems and their operation of the several electrical or electronics devices. Also, to emphasis on important electrical installation used in domestics or household purposes.

Course Outcomes:

On completion this course, students will be able to

- To understand and analyze basic electrical and electronics circuits
- To study the working principles of electrical machines and energy converters.
- To introduce the components of low voltage electrical installations.
- Understand about digital electronics. They will get insights on digital logics theorems and basic combinational logic devices.

Unit - 1

08

- Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, Superposition, Thevenin and Norton Theorems. Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonances, Concept of Transformer.

Unit - 2

08

- **Components of LT Switchgear:** Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries, power factor improvement and battery backup.

Unit - 3

07

- **Diodes and Applications covering, Semiconductor Diode** - Ideal versus Practical, Resistance Levels, Diode Equivalent Circuits, Load Line Analysis; Diode as a Switch, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters.

Unit - 4

07

- Various Number systems, Decimal to Binary and Binary to Decimal Conversion, BCD, Octal and Hexadecimal numbers, Negative numbers representation, 1's, 2's, Complements, Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR Integrated Circuits (ICs)

References:

1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill.
2. S.K. Bhattacharya, “Basic Electrical and Electronics Engineering”, Pearson Education; Second edition 15 July 2017.
3. Electronic Devices and Circuits” Salivahanan, N Suresh Kumar, 3/e, McGraw Hill Publications, 2013.
4. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.
5. Robert L. Boylestad / Louis Nashelsky, “ Electronic Devices and Circuit Theory”, Latest Edition, Pearson Education.

BVR105P

INDUSTRIAL TRAINING/ON JOB TRAINING/ WORKSHOP

SEMESTER - 02

BVR201

FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE

Course Objectives:

- To make students familiar with basics of Artificial Intelligence etc.
- To develop the problem-solving ability

Course Outcomes:

On completion this course, students will be able to

- Design user interfaces to improve human–AI interaction and real-time decision making.
- Design user interfaces to improve human–AI interaction and real-time decision making.
- Explain the main concepts, models, technologies, and services of cloud computing, the reasons for the shift to this model, and its advantages and disadvantages.

Unit - 1

08

- Definition of AI, birth of AI, brief history, Turing test, Types of environment, Types of agents, PEAS Performance measure, Environment, Actuators, Sensors), Introduction to searching, State Space, SAGP (State, Action, Goal test, Path cost), DFS, BFS (Completeness, Time complexity)

Unit - 2

08

- Constrain Satisfaction Problems examples, Approaches to solve CSPs, Test and generate method, back tracking. Game Playing, Optimal decision in games, Min Max algorithm, Evaluation functions, Introduction to Propositional Logic and First Order Logic, Syntax, Substitution

Unit - 3

07

- Probabilistic Reasoning, Review of Probability Theory, Probabilistic Inference Rules, Bayes Theorem, examples of Bayes theorem, Introduction to Learning, Taxonomy of Learning Systems, Concept Learning, Find-S algorithm, Candidate Elimination Algorithm.

Unit - 4

07

- Introduction to Neural Networks, Introduction to Neural Networks, Biological Neural Networks, Artificial Neural Networks, Perceptron, Perceptron Learning Rule, Delta Rule, Applications of Neural Networks.

References:

1. Dr. K. Saraswathi Dr. A Rajasekaran, Dr. T. Dinesh Kumar, Fundamentals of Artificial Intelligence, Book Rivers (25 September 2023).
2. Stuart Russel and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson Education; 4th edition.
3. Reema Thareja, Artificial Intelligence: Beyond Classical AI, Pearson Education

BVR202

ENVIRONMENTAL STUDIES

Course Outcomes:

- Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
- Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
- Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
- Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
- Master core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.

Unit - 1:

06

Introduction to Environmental Studies:

- Multidisciplinary nature of environmental studies, Scope and importance; concept of sustainability and sustainable development.

Ecosystems:

- What is an ecosystem? Structure and function of the ecosystem;
- **Energy flow in an ecosystem:** food chains, food webs and ecological succession.
- **Case studies of the following ecosystems:** Forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit - 2

06

Natural Resources:

- **Renewable and Non-renewable Resources:** Land resources and land use change; Land degradation, soil erosion and desertification.
- **Deforestation:** Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- **Water:** Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- **Energy resources:** Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit - 3

06

Biodiversity and Conservation:

- **Levels of biological diversity:** genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots, India as a mega-biodiversity nation; Endangered and endemic species of India
- **Threats to biodiversity:** Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions;
- **Conservation of biodiversity:** In-situ and Ex-situ conservation of biodiversity.
- **Ecosystem and biodiversity services:** Ecological, economic, social, ethical, aesthetic and Informational value.

Unit - 4

06

Environmental Pollution:

- Types, causes, effects and controls; Air, water, soil and noise pollution, Nuclear hazards and human health risks
- **Solid waste management:** Control measures of urban and industrial waste. Pollution case studies.

Environmental Policies & Practices:

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- **Environment Laws:** Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Unit - 5

06

Human Communities and the Environment:

- **Human population growth:** Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies.
- **Disaster management:** floods, earthquake, cyclones and landslides.
- **Environmental movements:** Chipko, Silent valley, Bishnois of Rajasthan.
- **Environmental ethics:** Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

References:

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999. *Global Ethics and Environment*, London, Routledge.
4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. *Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science*, 339: 36--37.
7. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29--64). Zed Books.
8. McNeill, John R. 2000. *Something New Under the Sun: An Environmental History of the Twentieth Century*.
9. Odum, E.P., Odum, H.T. & Andrews, J. 1971. *Fundamentals of Ecology*. Philadelphia: Saunders.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. *Environmental and Pollution Science*. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India*. Tripathi 1992.
14. Sengupta, R. 2003. *Ecology and economics: An approach to sustainable development*. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology: Voices from the Tropics*. John Wiley & Sons.
17. Thapar, V. 1998. *Land of the Tiger: A Natural History of the Indian Subcontinent*.
18. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
19. Wilson, E. O. 2006. *The Creation: An appeal to save life on earth*. New York: Norton.
20. World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press.

BVR203

APPLIED MATHEMATICS

Course Objective:

- To provide the students with sufficient knowledge of differential equations, higher orders, power series and Fourier series, so that it can be used in their respective fields.

Course Outcomes:

On completion this course, students will be able to

- Analyze the behavior of functions by using differential equations concepts.
- To understand second order and higher order differential equations.
- To understand series solutions and to apply in higher order applications.
- Analyze Fourier series, partial differential equations and to apply in further synthesis.

Unit - 1

08

- **Differential equations of first order & of first degree:** Linear form, reducible to linear form, exact form, Reducible to exact form, Picard's Theorem (Statement only).

Unit - 2

08

- Differential equations of second & higher order with constant coefficients, Algebra of Limit, Continuous functions, Differentiability of a function, Algebra of derivatives, Application of derivatives, increasing and decreasing functions, Tangents and normal.

Unit - 3

07

- Sequence, Power series, radius of conversions, solution in series of second order LDE with variable co-efficient (C.F. only). Regular Single points and extended power series (Frobenius Method).

Unit - 4

07

- Fourier series, half range series, change of intervals, harmonic analysis. Formulation and classification of linear and quasi linear partial differential equation of the first order, Lagrange's method for linear Partial Differential Equation of the first order.

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley.
2. B.V. Ramana, Higher Engineering Mathematics, McGraw – Hill.
3. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage Learning, NewDehli
4. M Ray, A Text Book On Differential equations Students Friends & Co., Agra-2
5. Robert C. Mcowen, Partial Differential Equation Pearson Education.
6. George F. Simmons & S.G. krantz, Differential Equation Tata McGraw – Hill.
7. R.K. Jain & S R K Iyengar, Advanced Engineering Mathematics, Narosa
8. T Amarnath , An Elementary course in partial differential equations, Narosa, New Delhi.
9. S. G. Deo and V. Raghavendra: Ordinar Differential Equations, Tata McGraw Hill Pub. Co., New Delhi

BVR204

BASICS OF MECHANICAL SYSTEMS

Course Objective:

- The main objective of this course is to make the students acquainted with the basics of mechanical systems. Preliminary ideas on forces and fluid dynamics are also essential to know.

Course Outcomes:

On completion this course, students will be able to

- To understand the basics of various mechanical systems.
- To study the working principles of various sensors for automation.
- To introduce electrical machines for automations.
- To acquire knowledge on PLC and apply for the development of various automated systems.

Unit - 1

08

- **Mechanical Systems:** Gears, drives, bearings, pulleys etc. Stress, strain, elastic constraints, stress in circular shaft subjected to pure torsion only, Riveted and bolted joints.

Unit - 2

08

- Elementary idea of Shear force and bending moment for concentrated, uniformly distributed loads simply supported beam cantilever and overhanging beam, Simple Shear force and bending moment diagrams, Relationship between shear force and bending moment

Unit - 3

07

- Classification of Pulleys, Types of Belts, Simple calculation of pulley diameter, Classification of Gears, Simple calculation of number of teeth and speed, Power transmission by solid and hollow shaft

Unit - 4

07

- Properties of fluids, pressure of fluid and its measurement. Flow of fluids, velocity and discharge, Bernoulli's theorem and its application in venturimeter, flow through pipe, head loss due to friction.

References:

1. M.P. Poonia & S.C. Sharma, "Basic Mechanical Engineering, Khanna Publishing House
2. D.S. Bedi, Strength of Materials, Khanna Publishing House

BVR205P

INDUSTRIAL TRAINING/ON JOB TRAINING/WORKSHOP

SEMESTER - 03

BVR301

AUTOMATIC CONTROL SYSTEM

Course Objectives:

- To study the basics of control system and its response, stability of mechanical and electrical system.

Course Outcomes:

- Able to expose students to the state space representation and its analysis.
- Able to introduce non-linear systems and their control. To impart knowledge on advanced control techniques

Unit - 1

08

Introduction:

- Open loop and closed loop systems - Examples - Elements of closed loop systems - Transfer function - Modelling of physical systems – Mechanical and Electrical, Transfer function of DC generator, Block diagram - reduction techniques, Signal flow graph – Mason's gain formula. Modes- Speed mode & torque mode.

Unit - 2

08

Time Domain Analysis:

- **Standard Test signals** - Time response of second order system - Time domain specifications - Types of systems - Steady state error constants - Introduction to P, PI and PID modes of feedback control.

Unit - 3

07

Frequency Domain Analysis:

- Frequency domain specifications - Time and frequency response correlation – Polar plot – Bode plot – All pass minimum phase and non-minimum phase systems.

Unit - 4

07

Root Locus Method:

- **Root locus concepts** - Construction of root loci – Root contours.
- **State Space Analysis:** Concepts of state, state variables and state model – state model for linear time invariant systems - Introduction to state space representation using physical - Phase and canonical variables.

References:

1. Ogata K, "Modern Control Engineering", Pearson Education, New Delhi, 2006.
2. Kuo B C, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.
3. Norman C. Nise S, "Control system Engineering", John Wiley & Sons, Singapore, 2004.
4. Nagrath I J, and Gopal, M, 'Control Systems Engineering' Prentice Hall of India, New Delhi, 2008.
5. Hasan Saeed, "Automatic Control System" Katson Publication-2013
6. Richard C Dorf and Robert H Bishop, "Modern Control Systems.", Addison-Wesley

BVR302

FUNDAMENTAL OF MECHATRONICS

Course Objective:

- The main objective of this course is to make the students acquainted with the basics of mechanical systems. Preliminary ideas on forces and fluid dynamics are also essential to know.

Course Outcomes:

On completion this course, students will be able to:

- To introduce Real Time Operating System with GUI and Simulation of mechatronics with trends, methods and applications of various sensors for automation.
- To study the introduction of Signal Conditioning, hardware, Digital I/O, Analog I/P, filtering noise using passive component etc.
- To understand and analyze precision of mechanical system for automations.
- To acquire knowledge of electrotechnical drivers, stepper motor, wave modulation for automated systems.

Unit - 1

08

- **Introduction:** Definition – Trends - Control Methods: Stand alone, PC Based (Real Time Operating Systems, Graphical User Interface, Simulation) - Applications: identification of Sensors and actuators in Washing machine, Automatic Camera, Engine Management, SPM, Robot, CNC, FMS, CIM.

Unit - 2

08

- **Signal Conditioning:** Introduction – Hardware - Digital I/O, Analog input – ADC, resolution, Filtering Noise using passive components – Registers, capacitors – Amplifying signals using OP amps – Software - Digital Signal Processing – Low pass, high pass, notch filtering

Unit - 3

07

- **Precision Mechanical Systems:** Modern CNC Machines – Design aspects in machine structures, guideways, feed drives, spindle and spindle bearings, measuring systems, control software and operator interface, gauging and tool monitoring.

Unit - 4

07

- **Electromechanical Drives:** Relays and Solenoids - Stepper Motors - DC brushed motors – DC brushless motors - DC servo motors -4-quadrant servo drives, PWM's - Pulse Width Modulation – Variable Frequency Drives, Vector Drives - Drive System load calculation.

References:

1. Mechatronics, Bolton w, Addison Wesley Longman Ltd., USA 1999, ISBN: 9780582357051
2. Mechatronics, H.M.T., McGraw-Hill Education, New Delhi, 2000, ISBN: 0074636435
3. Mechatronics Electronics in production and Process, Dawson D.A., Burd N.C., Loader A.J., Chapman-Hall, New Delhi, 2003, ISBN: 9780072402414
4. Mechanical Measurement and Instrumentation, Sawhney Puneet, Sawhney A.K., Dhanpat Rai and Sons, 2013, New Delhi

BVR303

PRINCIPLES OF ROBOTICS

Course Objectives:

- To introduce the functional elements of Robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control
- To educate on various path planning techniques
- To introduce the dynamics and control of manipulators

Course Outcomes:

On successful completion of the module students will be able to:

- Ability to understand basic concept of robotics.
- To analyze Instrumentation systems and their various applications.
- To know about the differential motion and statics in robotics
- To know about the various path planning techniques.
- To know about the dynamics and control in robotics industries

Unit - 1

08

- **Basic Concepts:** Brief history-Types of Robot–Technology-Robot classifications and specifications- Design and control issues- Various manipulators – Sensors - work cell - Programming languages.

Unit - 2

08

- **Direct and Inverse Kinematics:** Mathematical representation of Robots - Position and orientation – Homogeneous transformation-Variou joints- Representation using the Denavit Hattenberg parameters Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.

Unit - 3

07

- **Manipulator Differential Motion and Statics:** Linear and angular velocities-Manipulator Jacobian- Prismatic and rotary joints–Inverse Wrist and arm singularity - Static analysis - Force and moment Balance.

Unit - 4

07

- **Path Planning: Definition-Joint space technique** - Use of p-degree polynomial-Cubic polynomial- Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.
- **Dynamics and Control: Lagrangian mechanics** - 2DOF Manipulator-Lagrange Euler formulation- Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

References:

1. R.K. Mittal and I.J. Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
2. JohnJ. Craig, Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.
3. M.P. Groover, M. Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw Hill Singapore, 1996.
4. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
5. K. K. Appu Kuttan, Robotics, I K International, 2007.
6. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
7. R.D. Klafter, T.A. Chimielewski and M. Negin, Robotic Engineering - An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
8. B.K. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
9. S.G hoshal, - Embedded Systems & Robotics – Projects using the 8051 Microcontroller, Cengage Learning, 2009.

BVR304

INDUSTRIAL SAFETY PRACTICES

Course Objective:

- Industrial safety is needed to check all the possible chances of accidents for preventing loss of life and permanent disability of any industrial employee, any damage to machine and material.
- It is needed to eliminate accidents causing work stoppage and production loss.
- It is needed to reduce workman's compensation, insurance rate, and all the cost of accidents.
- It is needed to achieve better morale among industrial employees.

Course Outcomes:

On completion this course, students will be able to:

- Analyze the effect of release of toxic substances
- Understand the industrial laws, regulations and source models.
- Apply the methods of prevention of fire and explosions.
- Understand the relief and its sizing methods.

Unit - 1

08

- History of Safety. Movement in India and abroad. Need for safety, legal, humanitarian, economic and social considerations, Role of management in Industrial Safety.
- **Safety Management** - Principles & practices. National policy on Safety, Health & Environment at workplace.

Unit - 2

08

- Accident, Incident, injury, hazard, risk, danger, unsafe acts, unsafe conditions, dangerous occurrences, Type of Accidents, etc. Accident Prevention: Theories of accident causation; H.W. Henrich, Frank bird and Multiple causation theories of accident occurrences. Principles of accident prevention.

Unit - 3

07

- Understand importance of plant and work station design in safety, Significance of housekeeping in OSH, understand concepts of safety in machine guarding, use of tools, material handling and storage, appraise hazard associated with hot and cold work.

Unit - 4

07

- Understand elements of Environment Management system and ecosystem, Evaluate factors contributing water, air, soil and noise pollution and their effects, Apply various techniques of Environmental monitoring and waste management, Fulfil Sustainability reporting requirements.

References:

1. Katariya Sanjay B, "Industrial Automation Solutions For Plc, Scada, Drive And Field Instruments: Easy To Learn Industrial Automation", Notion Press; 1st Edition (23 May 2020).
2. Ravindra Sharma, "Advanced Industrial Automation and Its Applications", Laxmi Publications Pvt Ltd (1 January 2021).
3. R.G. Jamkar, "Industrial Automation Using PLC SCADA & DCS" Global Education Limited; second edition (1 January 2018)
4. Himanshu Kumar, "Advanced Industrial Automation: PLC programming in simplest way with 110 solved examples", Notion Press (1 July 2020).

BVR305P

INDUSTRIAL TRAINING/ON JOB TRAINING/ WORKSHOP

SEMESTER - 04

BVR401

CYBER SECURITY TOOLS TECHNIQUES AND COUNTER MEASURES

Course Objective:

- The course Cyber Security, Tools, Techniques and Countermeasures aims to provide a foundational platform for Cyber Security Aspirants by providing Cyber Security Awareness and Training that heighten the chances of catching a scam or attack before it is fully enacted, minimizing damage to the resources and ensuring the protection of information technology assets.

Course Outcome:

- Students will be able to acquire the knowledge of both the fundamentals of information systems as well as advanced topics in areas such as network security, cryptography, risk management, security governance, business continuity, security, architecture, physical security and critical infrastructures.

Unit - 1

08

- **Introduction:** Cyber Security Essentials, Attack Vectors, Threat, Risk and Vulnerability, Advanced Persistent Threat and Cyber Kill Chain, Cyber Security Framework

Unit - 2

08

- **Firewall and Attacks on Wireless Networks:** Firewall and Packet Filters, Introduction to Windows and Linux Firewall, Attacks on Wireless Networks, Scanning For Web Vulnerabilities Tools and HTTP Utilities

Unit - 3

07

- **Inspection Tools and Security Policy:** Application Inspection Tools, Password Cracking and Brute Force Tools, Web Attack, Information Security Basics to Policy

Unit - 4

07

- **Detection System and Security Assurance:** Intrusion Detection System, IT Assets and Wireless Security, Cyber Security Assurance Framework, Desktop Security and Malware
- **Social Engineering and IPR:** E-Commerce and Web-Application Security, Social Engineering, Intern

References:

1. Principles of Cyber Security Course Code: PGDCS-101 Published by Dr. Babasaheb Ambedkar Open University
2. Cyber Security Techniques: PGDCS-103 Published by Dr. Babasaheb Ambedkar Open University
3. https://onlinecourses.swayam2.ac.in/nou21_ge40/preview
4. Cyber Security – Understanding Cyber Crimes, Computer Forensics and Legal Perspectives Author: Nina Godbole, Sunit Belapure, Publisher: Wiley India
5. Information Systems Security – Security Management, Metrics, Frameworks and Best Practices Author: Nina Godbole, Publisher: Wiley India

BVR402

KINEMATICS AND DYNAMICS OF ROBOTICS

Course Objective:

- To make students familiar with the constructions and working principle of different types of sensors and transducers.
- To make students aware about the measuring instruments and the methods of measurement and the use of different transducers.

Unit - 1

08

- Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, Purpose of sensors, internal and external sensors, common sensors

Unit - 2

08

- Introduction, Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots; Active and passive joints, Constraint and loop-closure equations, Direct kinematics problems.

Unit - 3

07

- Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators, Generation of symbolic equations of motion using a computer, Simulation (direct and inverse) of dynamic equations of motion.

Unit - 4

07

- Models of flexible links and joints, Kinematic modeling of multi-link flexible robots, Dynamics and control of flexible link manipulators, Numerical simulations results, Experiments with a planar two-link flexible manipulator.

References:

1. Chang Liu, "Foundations of MEMS", Pearson; 2nd edition (26 May 2011)
2. Gabriel M.Rebiz, "RF MEMS Theory, Design and Technology", John Wiley & Sons.
3. Eun Sok Kim, Fundamentals of Micro electromechanical Systems (MEMS), 1st Edition.

BVR403

ROBOTIC CONTROL SYSTEMS

Course Objectives:

- To introduce the overview of robotic systems and their dynamics
- To impart knowledge on system stability
- To acquire knowledge on joint space and task space control schemes
- To understand the concept of nonlinear control and observer schemes

Course Outcomes:

On successful completion of the module students will be able to:

- Understand basic concept of robotic systems and their dynamics.
- Analyze system stability and types of stability
- Know about joint space and task space control schemes
- Understand the concept of nonlinear control and observer schemes

Unit - 1

08

Introduction and Overview of Robotic Systems and Their Dynamics:

- Forward and inverse dynamics. Properties of the dynamic model and case studies.
- Introduction to nonlinear systems and control schemes.

Unit - 2

08

System Stability and Types of Stability:

- Lyapunov stability analysis, both direct and indirect methods. Lemmas and theorems related to stability analysis.

Unit - 3

07

Joint Space and Task Space Control Schemes:

- Position control, velocity control, trajectory control and force control.

Nonlinear Control Schemes:

- Proportional and derivative control with gravity compensation, computed torque control, sliding mode control, adaptive control, observer based control, robust control and optimal control.

Unit - 4

07

Nonlinear Observer Schemes:

- Design based on acceleration, velocity and position feedback. Numerical simulations using software packages namely MATLAB/MATHEMATICA.

References:

1. R Kelly, D. Santibanez, LP Victor and Julio Antonio, - Control of Robot Manipulators in Joint Space, Springer, 2005.
2. A Sabanovic and K Ohnishi, - Motion Control Systems, John Wiley & Sons (Asia), 2011
3. R M Murray, Z. Li and SS Sastry, - A Mathematical Introduction to Robotic Manipulation, CRC Press, 1994.
4. J J Craig, - Introduction to Robotics: Mechanics and Control, Prentice Hall, 4th Ed, 2018

BVR404

PROGRAMMING FOR ROBOTICS

Course Objectives:

- To acquire the knowledge on advanced algebraic tools for the description of motion.
- To analyze and design the motion for articulated systems
- To develop an ability to use software tools for analysis and design of robotic systems.

Course Outcomes:

- On successful completion of the module students will be able to:
- Understand the matrix algebra and Lie algebra for computing the kinematics of robots
- Analyze the forward kinematics and inverse kinematics of serial and parallel robots
- Do the path planning for a robotic system

Unit - 1

08

Basics of Robotics:

- History – Definition – Components – Building a robot – The Robot drive mechanism.
- **Robot Simulation:** Mathematical modeling of the robot - Robot kinematics – Concepts of ROS and Gazebo.

Designing Chefbot Hardware:

- Specifications - Block diagram - Working with Robotic Actuators and Wheel Encoders - Interfacing DC geared motor with Tiva C LaunchPad - Interfacing quadrature encoder with Tiva C Launchpad - Working with Dynamixel actuators.

Unit - 2

08

Working With Robotic Sensors:

- Working with ultrasonic distance sensors - Working with the IR proximity sensor -Working with Inertial Measurement Unit.

Unit - 3

07

Python and ROS:

- Introduction to OpenCV, OpenNI, and PCL - Programming Kinect with Python using ROS, OpenCV, and OpenNI - Working with Point Clouds using Kinect, ROS, OpenNI, and PCL.

Unit - 4

07

Interfacing it into ROS, Using Python:

- Building ChefBot hardware - Writing a ROS Python driver for ChefBot - Understanding ChefBot ROS launch files - Working with ChefBot Python nodes and launch files - The Calibration and Testing of ChefBot - The Calibration of Xbox Kinect using ROS - Wheel odometry calibration - Testing of the robot using GUI.

References:

1. Lentin Joseph, —Learning Robotics using Python, PACKT Publishing, 2015.
2. Aaron Martinez and Enrique Fernandez,—Learning ROS for Robotics Programming, PACKT Publishing, 2013, 2nd Ed, 2015.
3. Bill Smart, Brian Gerkey, Morgan Quigley, — Programming Robots with ROS: A Practical Introduction to the Robot Operating System, O Reilly Publishers, 2015.

BVR405P

INDUSTRIAL TRAINING/ON JOB TRAINING/ WORKSHOP

SEMESTER - 05

IOT AND EMBEDDED SYSTEMS

BVR501

Course Objective:

- The main objective of this course is to make the students acquainted with the basics of embedded systems. Preliminary ideas on architecture of microcontroller, C programming and simulation are also essential to know.

Course Outcomes:

On completion this course, students will be able to:

- To acquire knowledge of basic function, characteristic and application of Embedded C Software in the modern embedded systems and on the function and area of application of Arduino and Microcontroller based embedded systems used in modern electronics control and Artificial Intelligence Systems.
- To understand the Embedded C programming simulation model for Arduino automation.
- To introduce PIC 18 Architecture and its programming.
- To acquire knowledge on I/O interfacing, Programming and Simulation model.

Unit - 1

08

- **Embedded System Design Basics:** Introduction to embedded systems, Components of embedded system, Comparison among 8051, Arduino and PIC Architecture review of Arduino Uno board: Introduction to ARDUINO, ARDUINO History and Family- Mega, Nano, Bluetooth, LilyPad, Pin configuration and architecture Of ATmega328 microcontroller, Study of an Arduino Board- Power Supply, Power Connectors, Analog Inputs, Digital Connections

Unit - 2

08

- **Embedded C programming simulation model for Arduino:** Introduction to Embedded C and steps to install Arduino Integrated development platform, Basic commands for Arduino Functions, Parameters, Variables- Global, local and static, Numeric variables-Int, Float, Boolean, # Define directives, Looping statements-if, for, while, Logical Operators, Mathematical operators, Return values, Coding styles.

Unit - 3

07

PIC 18 Architecture and its programming:

- PIC 18 architecture and assembly level programming – The WREG register in PIC, PIC file register, using instruction with the default access bank, Status register, PIC data format and directives, Branch, call and time delay loop,
- Proteus simulation model for PIC
- PIC I/O port programming
- ADC programming

I/O interfacing, Programming and Simulation model:

- LED interfacing with Arduino /PIC - Circuit diagram, program for LED blinking.
- 2Single switch and seven segment interface with Arduino /PIC - Circuit diagram.
- Sensors (Temperature, Light, Proximity) and LED/LCD interface with Arduino /PIC Circuit diagram, program.
- Interfacing with DC motor with Arduino /PIC–speed control program with direction change: Circuit diagram, program, Proteus simulation model.

References:

1. Arduino-Based Embedded System, Rajesh Singh, Anita Gehlot, Bhupendra Singh and Sushabhan Choudhary, Taylor& Francis.
2. Fundamentals of Microcontrollers and Applications in Embedded System (with the PIC 18 microcontroller family), R. Gaonkar, Penram International Publishing.
3. Embedded C, Pont, Michael J, Addison-Wissley professional.
4. Getting Started with Arduino: The Open Source Electronic Prototyping Platform, Massimo Banzi, Shroff Publishers & Distributors Pvt Ltd, 2014.
5. Programming Aurdino: Getting Started with Sketches, Simon Monk, McGraw-Hill Education, Second Edition, 2016.
6. Arduino Cookbook, Margolis, Shroff/O'Reilly Publication, 2nd edition, 2012.
7. Embedded Systems, Himanshu Dave, Parag Dave, Pearson (ISBN: 9789332543522).
8. The Essential PIC 18 Microcontroller, Sid Katzen, Springer.
9. PIC Microcontroller and Embedded System using Assembly and C for PIC 18, M A Mazidi, R D Mckinlay and D Causey, Pearson.

BVR502

SENSORS AND ACTUATORS FOR ROBOTICS

Course Outcomes:

At the end of this course, the students will be able to:

- Analyze sensory systems in robotics.
- Select the sensor for robotic application and design the systems.
- Analyze actuators and configuring the parameters of Actuators.

Unit - 1

08

- **Anatomy of Robotic system:** links and joints in robots, types of joints, end effectors, concept of degrees of Freedom and its calculations.
- **Sensors:** Pressure/contact. Resistive position. Infrared. Light. Position Sensors, optical encoders, proximity sensors, Range sensors, Ultrasonic sensors, Touch and Slip sensors. Sensors for motion and position, Force, torque and tactile sensors, Flow sensors, Temperature sensing devices.

Unit - 2

08

- **Vision Sensors:** Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation.

Unit - 3

07

- **Advanced Sensor Technology:** Smart sensors, MEMS based sensors, Innovations in sensor technology ctuators and its selection while designing a robot system. Types of transmission systems.
- **Electric Actuators:** Direct current motor, Permanent magnet stepper motor, Servo Control DC motors, Linear and latching linear actuators, Rotary actuators, Piezoelectric actuators, Actuator parameters and characteristics, Stepper motors, Specifications and characteristics of Stepper Motors Servo Motors.

Unit - 4

07

- **Pneumatic & Hydraulic actuators: Hydraulic and pneumatic power actuation devices:** Hydraulic Actuators, selection of linear actuating cylinders, Hydraulic Motors, Pneumatic actuators, design considerations and selection, pneumatic cylinders, pneumatic drive system, Linear & rotary actuators. Advanced actuators – Piezoelectric actuators, elastomer actuators, oft actuators, and shape memory alloy based actuators, under actuated robotic hand.

References:

1. D. Patranabis, Sensors and Transducers, PHI, 2nd Edition 2013.
2. Jon S. Wilson, Sensor Technology Handbook, Elsevier, 2005.
3. Mc Comb, G. Robot builder's bonanza. 5th ed. New York: McGraw-Hill, 2019. ISBN 9781260135015.
4. Braünl, T. Embedded robotics: mobile robot design and applications with embedded
5. systems. 3rd edition Berlin; Heidelberg: Springer, 2008. ISBN 9783540705338.
6. Martin, F.G. Robotic explorations: a hands-on introduction to engineering. Upper Saddle
7. River, N.J.: Prentice-Hall, 2001. ISBN 0130895687.
8. Gerard C., M. Meijer, Smart Sensors System, Wiley, 2008.
9. Andrzej M. Pawlak, Sensors and Actuators in mechatronics, Taylor & Francis Group, 2007.
10. S. R. Ruocco, Robot Sensors & Transducers, Springer, 2013.

BVR503

ROBOT SAFETY AND MAINTENANCE

Course Outcomes:

At the end of this course, the students will be able to:

- Understand the safety factors of robots.
- Know the safety standards in case of Robots.
- Understand the concept of how to do maintenance.
- Analyze and rectify the Human errors causing accidents.

Unit - 1

08

- **Introduction to Robot Safety:** Introduction, Safety-Related Terms and Definitions, Organizations Concerned with Safety, Introduction, Robotic Safety Problems and Hazards, Use of Robots to Promote Safety, Weak Points in Planning and Design, \Operations Causing Safety Problems, The Manufacturer's and User's Role in Robot Safety, Safety Considerations in Robot Design, Installation, Programming, and Operation and Maintenance, Robot Safeguard Methods.
- **Robot Accidents:** Introduction. Real-Life Examples of Robot Accidents Robot Accidents in Japan, Western Europe, and the United States Causes and Characteristics of Robot Accidents Effects of Robot Accidents and Periods Off Work Due to Robot Accidents Robot Accidents at Manufacturer and User Sites Robot Accident Analysis and Prevention.

Unit - 2

08

- **Robot Safety and Safety devices:** Introduction, Robot Safety Education, Safety Considerations in Robot Testing and Start-Up, Commissioning, and Acceptance, Safety Considerations in Robot Welding Operations, Robot Safety in the Automobile Industry, Stopping Grippers of Industrial Robots Not Dropping Throwing Work Items When Experiencing Energy Loss or Not Gripping on the Return of Energy , Robot Standardization and Safety Standards, , Safety Devices, STOP type of a Robot, Emergency Stop, Mode select switch, Deadman switch, Safeguards, Operation inside of the safety fence, Safety Procedures for entering the safety fence.

Unit - 3

07

- **Human Factors in Robotics:** Introduction, Robots Versus Humans , Human Factors' Issues During the Factory Integration of Robotic Systems, Built-In Human Biases and Some Design Improvement Guidelines for Improving Robot Operator Comfort and Productivity, Benefits and Drawbacks of Robotization from the Standpoint of Human Factors and Rules of Robotics with Respect to Humans, Humans at Risk from Robots and Guidelines for Safeguarding the Operator and the Teacher, Human Factors' Considerations to Robotic Safety, Training for Reducing Human Error in Robotics and Human Error Data in Robotics, Reliability Analysis of a Robot System with Human Error.

Unit - 4

07

- **Robot Maintenance:** Introduction, General Maintenance Functions and Types of Maintenance, Robot Maintenance Needs and Types, Robot Parts and Special Tools for Maintenance and Repair, Robot Warranty Coverage and Preventive Maintenance Kits, Robot Inspection, Some Guidelines for Safeguarding Robot Maintenance Personnel, Some Models Useful in Performing Robot Maintenance.
- **Safety Standards for Robotic Technology:** BIS and ISO safety standards for Robots, Safety management system, Hazard identification, Risk analysis and Evaluation, Audit Programme, Preventive Maintenance of Robots, Accident Prevention Techniques, Ergonomics of robots handling, Safety management and management principles, Major accident control, Safety Training, Robotics Safety Requirements.

References:

1. B.S. Dhillon, "Robot Reliability and Safety", CRC Press, 2015.
2. Paolo Barattini et. al., "Human Robot Interaction: Safety, Standardization and Benchmarking", CRC Press, 2019.
3. Nicholas Odrey, "Industrial Robotics -Technology, Programming and Applications", 2017.
4. Mikell Groover, "Industrial Robotics, Tata McGraw Hill, 2008.
5. Tom Taulli, "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Springer India, 31 December 2021.

BVR504

ROBOT SYSTEM DESIGN AND SLAM (SIMULTANEOUS LOCALIZATION AND AREA MAPPING)

Course Outcomes:

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

- Understand the features and uses of Robotic Operating System (ROS) and allied software tools.
- Generate a robot manipulator and its working environment using simulation tools.
- Implement robot navigation and object manipulation for a given application.
- Incorporate and use robot vision for real-world applications.

Unit - 1

08

- **Introduction:** Industrial Applications of Robots, Industrial Environments and Constraints, Free Open Source Software for Robot Simulation, Robotic Operating System (ROS), Gazebo, MoveIt, Ubuntu, Python, Installing and Configuring Simulation Softwares.

Unit - 2

08

- **Robotic Operating System:** Robotic Operating System (ROS) Fundamentals, Building a ROS Application, ROS Services, ROS Actions, Unified Robot Description Format (URDF).

Unit - 3

07

- **Robot Navigation: Slam:** Simultaneous Localization and Mapping (SLAM) implementation with ROS2 packages and C++. Combining mapping algorithms with the localization concepts, Introduction to the Mapping and SLAM concepts and algorithms. Occupancy Grid Mapping, Mapping an environment with the Occupancy Grid Mapping algorithm, Grid-based FastSLAM: Simultaneous mapping an environment and localize a robot relative to the map with the Grid-based FastSLAM algorithm, Self-Localisation, Path Planning and Obstacle Avoidance, Map-Building and Map Interpretation, Simultaneous Localization and Mapping, Navigation using Software Tools.

Unit - 4

07

- **Manipulation:** Object Manipulation, Manipulation Planning Algorithms, Prehension, Manipulation using Software Tools.
- **Robot Vision:** Object Detection, Pose Estimation, Logical Camera, ROS Tools for Vision.

References:

1. Morgan Quigley, "Programming Robots with ROS: A Practical Introduction to the Robot Operating System", O'Reilly Media, 2015.
2. Carol Fairchild, Dr. Thomas L. Harman, "ROS Robotics by Example", Packt, 2016.
3. Anis Koubaa, "Robot Operating System", Springer link, 2016.
4. Anil Mahtani, "Effective Robotics Programming with ROS", Packt Publishing, 2016.
5. Ramkumar Gandhinathan , Lentin Joseph , " ROS Robotics Projects: Build and control robots powered by the Robot Operating System, machine learning, and virtual reality", Packt Publishing Limited, December 2019.
6. SLAM for dummies:
https://dspace.mit.edu/bitstream/handle/1721.1/119149/16412jspring-2005/contents/projects/1aslam_blas_repo.pdf
7. ROS Robot Programming; YoonSeok Pyo | HanCheol Cho | RyuWoon Jung | TaeHoon
8. Lim; <https://community.robotsource.org/t/download-the-ros-robot-programming-book-for-free/51>

BVR505P

INDUSTRIAL TRAINING/ON JOB TRAINING/ WORKSHOP

SEMESTER - 06

BVR601

INDUSTRIAL ROBOTICS AND MATERIAL HANDLING SYSTEM

Course Objectives:

- To introduce the basic concepts, parts of robots and types of robots.
- To make the student familiar with the various drive systems for robot, sensors and their applications in robots and programming of robots.
- To discuss about the various applications of robots, justification and implementation of robot.

Course Outcome:

- Able to design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.

Unit - 1

08

- **Introduction:** Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centered cell.

Unit - 2

08

- **Robots for Inspection:** Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.

Unit - 3

07

- **Other Applications:** Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications.

Unit - 4

07

- **End Effectors:** Gripper design, degrees of freedom. Types of end effectors & their uses.
- **Material Handling:** Concepts of material handling, principles and considerations in material handling systems design, conventional material handling systems - industrial trucks, monorails, rail guided vehicles.

References:

1. Richaerd D Klafter, Thomas Achmielewski and Mickael Negin, "Robotic Engineering – An integrated Approach" Prentice HallIndia, New Delhi, 2001.
2. Mikell P. Groover, "Automation, Production Systems, and Computer Integrated Manufacturing", 2nd Edition, John Wiley & sons, Inc, 2007
3. James A Rehg, "Introduction to Robotics in CIM Systems", Prentice Hall of India, 2002.
4. Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 1994

BVR602

HYDRAULIC AND PNEUMATIC DRIVES FOR ROBOTS

Course Outcomes:

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

- Select a fluid power actuation system for a given robotic application.
- Select components for designing a fluid power circuit.
- Assemble and operate a fluid power actuation system.
- Design fluid power actuation system for robotic application.

Unit - 1

08

- **Introduction:** Robot Actuation, Robotic Grippers, Characteristics of Actuating Systems, Comparison of Actuating Systems.
- **Fluid Power Systems:** Introduction of Fluid Power Systems, Properties of Fluids and Selection, Pascal's Law and Pressure Measurement, Fluid Flow and Measurement, Gas Laws.

Unit 2

08

- **Control Valves:** Fluid power control elements and standard graphical symbols, Directional, Pressure and Flow
- **Control Valves – Construction and Working, Rotary Valves, Pilot-Operated Valves Servo-valves.**

Unit - 3

07

- **Hydraulic and Pneumatic Power Supplies:** Hydraulic Power Packs, Hydraulic Loading Valve and Filters, Air Compressors & Receivers, Air Treatment and FRL Units, Pressure Regulation in Fluid Power Circuits.

Unit - 4

07

- **Fluid Power Actuators:** Linear actuators and their Construction, Rotary actuators and their Construction, Mounting Arrangements, Cylinder Dynamics, Speed Control.
- **Fluid Power Circuits & Control:** Control of Single and Double Acting Hydraulic Cylinders, Control of Single and Double Acting Pneumatic Cylinders, Electrical Controls for Fluid Power Circuits, Electro-hydraulic and Electro Pneumatic Circuits, Examples of Fluid Power Circuits in Robotics.

References:

1. Saeed B. Niku, "Introduction to Robotics – Analysis, Control, Applications", Wiley India Pvt. Ltd., 2010.
2. R. Mittal, Nagrath, "Robotics and Control", McGraw Hill Education, 2017.
3. Hydraulics and Pneumatics, Jagadeesha T; I. K. International Publishing House Pvt. Ltd., 2015.
4. Hydraulics and Pneumatics, Andrew Parr; Jaico Books, 1993. 124

BVR603

ROBOTICS FOR INDUSTRIAL AUTOMATION

Course Outcomes:

- To explain robot anatomy, classification, and applications of robots.
- To understand the various sensors, grippers and its selection in robotics.
- To obtain basic idea on working principle of various drives, actuators and control concepts.
- To program different robot operations and appreciate applications of robots in industry.

Unit - 1

08

- **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., Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Industrial applications of robot.

Unit - 2

08

- **Grippers and Sensors for Robotics:** Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basic gripper system.
- **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.

Unit - 3

07

- **Drives and Control for Robotics:** Drive - Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system. Control Systems: Types of Controllers, Introduction to closed loop control.

Unit - 4

07

- **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.

References:

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
2. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)
3. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)
4. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)
5. S. B. Niku, Introduction to Robotics – Analysis, Control, Applications, 3rd edition, John Wiley & Sons Ltd., (2020)
6. R. Siegwart, I. R. Nourbakhsh, "Introduction to Autonomous Mobile Robots", The MIT Press, 2011

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ARTIFICIAL INTELLIGENCE FOR ROBOTICS

Course Objectives:

- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Introduce the concepts of Expert Systems and machine learning.
- Learn about planning and reasoning artificial intelligence.
- Solve the risk in artificial intelligence.

Course Outcomes:

Upon successful completion of this course student will:

- To understand the basics of Artificial Intelligence, Intelligent Agents and its structure
- To understand the problem solving by various searching techniques
- To understand the concept of informed search and Exploration
- To understand the concept of constraint satisfaction Problems and Adversarial Search
- To Understand what is Reasoning and Knowledge Representation
- To understand the concept of Reasoning with Uncertainty & Probabilistic Reasoning
- To Understand the basic forms of Machine Learning, decision trees and statistical Learning setting

Unit - 1

08

- **Introduction:** History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents.
- **Problem Solving:** Solving problems by searching Informed search and exploration–Constraint satisfaction problems–Adversarial search, knowledge and reasoning–knowledge representation – first order logic.

Unit - 2

08

- **Planning:** Planning with forward and backward State space search – Partial order planning – Planning graphs–Planning with propositional logic – Planning and acting in real world.

Unit - 3

07

- **Reasoning Uncertainty** – Probabilistic reasoning–Filtering and prediction–Hidden Markov models Kalman filters–Dynamic Bayesian Networks, Speech recognition, making decisions.

Unit - 4

07

- **Learning:** Forms of learning – Knowledge in learning – Statistical learning methods –reinforcement learning, communication, perceiving and acting, Probabilistic language processing, perception.
- **AI In Robotics:** Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics.

References:

1. Stuart Russell, Peter Norvig, —Artificial Intelligence: A modern approach, Pearson Education, India 2009.
2. Negnevitsky, M, —Artificial Intelligence: A guide to Intelligent Systems,. Harlow: Addison-Wesley, 2011.
3. David Jefferis, —Artificial Intelligence: Robotics and Machine Evolution, Crabtree Publishing Company, 1999.

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INDUSTRIAL TRAINING/ON JOB TRAINING/ WORKSHOP



RAIPUR|INDIA

KALINGA UNIVERSITY

KALINGA UNIVERSITY, KOTNI , NEAR MANTRALAYA, NAYA RAIPUR - 492101, CHHATTISGARH

CALL: +91-9907252100