KALINGA UNIVERSITY

RAIPUR | INDIA

SCHEME & SYLLABUS FOR

Bachelor of Vocational Studies (B.Voc.) Mechatronics Technology

(W.e.f. 2025 – 2026)

NAAC GRADE B+ Accredited University

nirf RANKING 2025 Ranked in Top 101-150 Universities

Kalinga University, Naya Raipur, Chhattisgarh

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B.VOC SYLLABUS FOR MECHATRONICS TECHNOLOGY

Semester-01								
Course Code	**Course Title**	**Credits**	**L**	**T**	**P**	**Internal Marks**	**End Semester Exam Marks**	**Total Marks**
BVMT101	Communication Skills	3	3	0	0	30	70	100
BVMT102	Fundamentals of Information Technology	3	3	0	0	30	70	100
BVMT103	Fundamentals of Mechatronics	3	3	0	0	30	70	100
BVMT104	Metrology and Measuring Instruments	3	3	0	0	30	70	100
BVMT105P	**On Job Training/ Internship/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**
BVMT201	Tools, Equipment & Safety Measures	3	3	0	0	30	70	100
BVMT202	Environmental Studies	3	3	0	0	30	70	100
BVMT203	Hydraulics and Pneumatics	3	3	0	0	30	70	100
BVMT204	Electrical Machines and Control Systems	3	3	0	0	30	70	100
BVMT205P	**On Job Training/ Internship/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**
BVMT301	Material Science and Engineering	3	3	0	0	30	70	100
BVMT302	Fault Analysis & Repair	3	3	0	0	30	70	100
BVMT303	Applied Mechatronics	3	3	0	0	30	70	100
BVMT304	Principles of Machine Tools	3	3	0	0	30	70	100
BVMT305P	**On Job Training/ Internship/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**
BVMT401	Digital and Power Electronics	3	3	0	0	30	70	100
BVMT402	Industrial Automation	3	3	0	0	30	70	100
BVMT403	Industrial Drives and Controls	3	3	0	0	30	70	100
BVMT404	Microprocessor	3	3	0	0	30	70	100
BVMT405P	**On Job Training/ Internship/Workshop**	18	0	0	36	50	150	200
Total		**30**	**12**	**0**	**36**	**170**	**430**	**600**

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Semester-05								
Course Code	**Course Title**	**Credits**	**L**	**T**	**P**	**Internal Marks**	**End Semester Exam Marks**	**Total Marks**
BVMT501	Mechatronics System Design and Robotics	3	3	0	0	30	70	100
BVMT502	Manufacturing & Quality Norms	3	3	0	0	30	70	100
BVMT503	Fluid Power Engineering	3	3	0	0	30	70	100
BVMT504	Sensors and Transducers	3	3	0	0	30	70	100
BVMT505P	**On Job Training/ Internship/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**
BVMT601	Manufacturing Automation and Ergonomics	3	3	0	0	30	70	100
BVMT602	Industry 4.0	3	3	0	0	30	70	100
BVMT603	UPS and Inverter Technician	3	3	0	0	30	70	100
BVMT604	Entrepreneurship Development	3	3	0	0	30	70	100
BVMT605P	**On Job Training/ Internship/Workshop**	18	0	0	36	50	150	200
Total		**30**	**12**	**0**	**36**	**170**	**430**	**600**

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SEMESTER-01

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COMMUNICATION SKILLS
BVMT101

Course Outcomes:

After successful completion of this course, learners will be able to:

- Explain the fundamentals of communication, including its types, modes, channels, barriers, and the role of English as a global language in personal, academic, and professional contexts.
- Demonstrate effective verbal and non-verbal communication skills by applying appropriate strategies for interpersonal, group, social, and business communication while recognizing language variations, accents, and dialects.
- Develop effective speaking skills by participating confidently in interviews, group discussions, public speaking, dialogues, and other professional communication situations.
- Analyze and interpret written texts through effective reading, comprehension, translation, and critical evaluation of content, audience, purpose, tone, and stylistic features.
- Produce clear, coherent, and professional written communication by preparing reports, letters, notes, essays, articles, newsletters, diary entries, and other forms of written documents for academic and workplace applications.

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/ mis-communication 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:

- K. K. Sinha – Business Communication, Galgotia Publishing Company, New Delhi.
- Raman Sharma – Technical Communication: Principles and Practice, Oxford University Press India.
- Sanjay Kumar & Pushp Lata – Communication Skills, Oxford University Press India.
- Meenakshi Raman & Sangeeta Sharma – Technical Communication: Principles and Practice, Oxford University Press India.
- Krishna Mohan & Meera Banerji – Developing Communication Skills, Macmillan Education India.

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FUNDAMENTALS OF INFORMATION TECHNOLOGY BVMT102

Course Outcomes:

After successful completion of this course, learners will be able to:

- Explain the fundamentals of computer systems, including their characteristics, classification, historical development, hardware, software, and the von Neumann architecture.
- Identify and describe the functions of computer hardware components, memory devices, storage media, input/output devices, and peripheral equipment used in modern computing systems.
- Demonstrate an understanding of system software, application software, operating systems, programming languages, databases, utilities, and computer security concepts, including virus protection and open-source software.
- Explain the concepts of computer networks and the Internet, including networking components, Internet services, web technologies, e-mail communication, and methods of Internet connectivity.
- Apply the principles of information technology and basic programming concepts by explaining IT applications in various sectors, interpreting algorithms, pseudocode and flowcharts, and describing the stages of program development, testing, debugging, and documentation.

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:

- V. Rajaraman – Fundamentals of Computers, PHI Learning Pvt. Ltd., New Delhi.
- Reema Thareja – Computer Fundamentals and Programming in C, Oxford University Press India.
- E. Balagurusamy – Fundamentals of Computers, McGraw Hill Education (India) Pvt. Ltd., New Delhi.
- Ramesh Bangia – Computer Fundamentals and Information Technology, Firewall Media (Laxmi Publications), New Delhi.
- Alexis Leon & Mathews Leon – Fundamentals of Information Technology, Vikas Publishing House Pvt. Ltd., New Delhi.

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FUNDAMENTALS OF MECHATRONICS
BVMT103

Course Outcomes:

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

- Explain the fundamentals, scope, components, and applications of Mechatronics.
- Identify and describe mechanical components, actuators, and sensors used in Mechatronics systems.
- Develop basic C programs and understand embedded systems, automation, and control systems.
- Apply the Mechatronics design methodology to develop integrated engineering systems.
- Evaluate emerging technologies such as IoT, AI, and autonomous systems, along with future opportunities and challenges in Mechatronics.

Unit 1: **06**

Introduction to Mechatronics:

- Definition and Scope of Mechatronics
- Definition and overview of Mechatronics as an interdisciplinary field
- Objectives of Mechatronics
- Advantages and disadvantages of Mechatronics
- Importance of Mechatronics in modern industries
- Applications in manufacturing, robotics, and automation
- **Key components of Mechatronics:**
  - → Mechanical Engineering
  - → Electrical Engineering
  - → Electronics Engineering
  - → Computer Science
  - → Control Engineering

Unit 2: **06**

Mechanical Components, Actuators and Sensors:

- **Mechanical Components**
  - → Overview of mechanical systems used in Mechatronics
  - → Linkages, Gears, Cams
- **Actuators:**
  - → Types of actuators
  - → DC Motors
  - → Stepper Motors
  - → Servo Motors
  - → Pneumatic Actuators
  - → Hydraulic Actuators
  - → Solenoids
  - → Relays

- **Sensors:**
  - → Definition of Sensors
  - → Applications of Sensors in Mechatronics
  - → Position sensors
  - → Velocity sensors
  - → Acceleration sensors
  - → Pressure sensors
  - → Temperature sensors
  - → Force sensors
  - → Displacement sensors

Unit 3: **06**

Computer Systems, C Programming and Control Systems:

- **Computer Systems in Mechatronics:**
  - → Role of computers in Mechatronics
  - → Embedded systems, Microcontrollers
  - → Real-time control systems
- **Basics of C Programming:**
  - → Data types, Keywords
  - → Decision making statements
  - → If, if-else
  - → Looping statements
- **Programs**
  - → Find the factorial of a given number
  - → Check whether a number is odd or even
  - → Find the sum of first n numbers
  - → Display a 3 × 3 matrix
  - → Find the sum of two 3 × 3 matrices
- **Control Systems**
  - → Introduction to control systems
  - → Automation and its role in industrial applications
  - → Difference between manual and automated systems
  - → Types of automation
  - → Fixed automation
  - → Programmable automation
  - → Flexible automation
  - → Open-loop control systems
  - → Closed-loop control systems
  - → Feedback control systems

Unit 4: **06**

Mechatronics System Design and Applications:

- **System Design Methodology:**
  - → Overview of the Mechatronics design process
  - → Requirement analysis
  - → Conceptual design
  - → Detailed design
  - → Testing and validation
  - → Steps involved in designing Mechatronics systems
  - → Integration of mechanical, electrical, electronic, and software components
- **Applications of Mechatronics:**
  - → Washing machine
  - → Automatic camera
  - → CNC machine

Unit 5: **06**

Emerging Technologies and Future Trends in Mechatronics:

- **Emerging Technologies:**
  - → Internet of Things (IoT) and its integration with Mechatronics
  - → Artificial Intelligence (AI) in Mechatronics
  - → Machine Learning in automation and robotics
  - → Smart systems
  - → Autonomous systems
  - → Drones
  - → Self-driving vehicles
  - → Industrial robots
- **Challenges and Opportunities:**
  - → Integration challenges
  - → Cost considerations
  - → System complexity
  - → Future opportunities
  - → Smart manufacturing
  - → Sustainable engineering
  - → Healthcare applications

References:

- W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 7th Edition, Pearson Education, 2021.
- Devdas Shetty and Richard A. Kolk, Mechatronics System Design, 2nd Edition, Cengage Learning, 2010.
- N. P. Mahalik, Mechatronics: Principles, Concepts and Applications, McGraw-Hill Education (India), 2017.
- K. P. Ramachandran, G. K. Vijayaraghavan and M. S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., 2008.
- William C. Durham, Introduction to Mechatronics and Measurement Systems, 5th Edition, McGraw-Hill Education, 2020.

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METROLOGY AND MEASURING INSTRUMENTS BVMT104

Course Outcomes:

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

- Explain the principles of metrology, measurement standards, calibration procedures, and measurement errors.
- Select and operate appropriate linear, angular, and physical property measuring instruments for engineering applications.
- Apply limits, fits, tolerances, GD&T principles, interferometry, and surface metrology techniques for dimensional inspection.
- Perform measurements of screw threads, gears, tapers, radii, and utilize various comparators for precision measurement.
- Analyze machine tool metrology and apply advanced metrology techniques including CNC systems, laser vision, 3D metrology, and modern optical measurement technologies.

Unit 1: **06**

Fundamentals of Metrology and Measurement:

- **Introduction to Metrology:** Definition and scope of metrology, Types of metrology, Need for inspection, Measurement terminologies, Methods of measurement, Units of measurement, Selection of measuring instruments, Measurement standards, Calibration, Statistical concepts in metrology
- **Measurement Errors:** Concept of errors, Systematic errors, Random errors, Sources of errors, Accuracy and precision

Unit 2: **06**

Linear, Angular and Property Measurements:

- **Linear Measurements:** Steel rule, Calipers, Vernier caliper, Vernier height gauge, Vernier depth gauge, Micrometers, Universal caliper, Surface plates (size, accuracy and materials), Slip gauges and calibration, Length bars, Dial indicator,
- **Angular Measurements:** Bevel protractor, Spirit level, Sine bar, Angle gauges
- **Measurement of Physical Properties:** Temperature measurement, Force measurement, Weight measurement, Pressure measurement, Flow measurement, Noise measurement, Lux measurement, Vibration measurement, Concept of fitting, tightening and torqueing in assembly lines

Unit 3: **06**

Limits, Fits, GD&T and Surface Metrology:

- **Limits, Fits and Tolerances:** Interchangeability, Selective assembly, Limits, Fits, Tolerances, Limit gauging, Design of limit gauges, Computer-aided tolerancing
- **Measurement of GD&T Parameters:** Straightness, Flatness, Squareness, Parallelism, Roundness, Cylindricity, Non-contact profiling systems
- **Surface Metrology:** Introduction, Surface finish terminology, Surface roughness specification on drawings, Surface roughness parameters, Factors affecting surface roughness, Ideal surface roughness, Surface roughness measurement methods, Precautions during measurement, Surface microscopy, Surface finish software
- **Interferometry:** Principle of interference, Interference bands, Interference patterns, Flatness interferometer, Gauge length interferometer

Unit 4: **06**

Screw, Gear Metrology and Comparators:

- **Screw Thread Metrology:** Introduction, Screw thread terminology, Screw thread measurement
- **Gear Metrology:** Introduction, Types of gears, Gear terminology, Gear teeth measurement, Errors in gears, Advanced measurement of spur gears
- **Comparators:** Features of comparators, Classification of comparators, Mechanical comparators, Electrical comparators, Optical comparators, Pneumatic comparators, Advanced comparators, Thread comparators
- **Miscellaneous Measurements:** Taper measurement, Radius measurement, Angle measurement

Unit 5: **06**

Machine Tool Metrology and Advanced Metrology:

- **Metrology of Machine Tools:** Alignment tests, Practical tests
- **Advanced Metrology:** Advanced measuring machines, CNC measuring systems, Laser vision systems, In-process gauging, 3D metrology, Metrology software, Nanotechnology instrumentation, Stage position metrology, Testing and certification services, Optical system design, Lens design, Coating design, Precision lens assembly techniques, Complex opto-mechanical assemblies, Contact bonding and joining technologies

References:

- R. K. Jain, Engineering Metrology, 21st Edition, Khanna Publishers, New Delhi.
- C. Gupta, Engineering Metrology, Dhanpat Rai Publications, New Delhi.
- T. G. Beckwith, R. D. Marangoni, and J. H. Lienhard V, Mechanical Measurements, 6th Edition, Pearson Education.
- B. C. Nakra and K. K. Chaudhry, Instrumentation, Measurement and Analysis, 4th Edition, McGraw-Hill Education.
- Alan S. Morris and Reza Langari, Measurement and Instrumentation: Theory and Application, 3rd Edition, Academic Press (Elsevier).

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ON JOB TRAINING/INTERNSHIP/WORKSHOP
BVMT105P

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SEMESTER-02

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TOOLS, EQUIPMENT & SAFETY MEASURES
BVMT201

Course Outcomes:

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

- Identify various manufacturing tools, equipment, and different types of cables used in industrial applications.
- Select appropriate connectors, sockets, and electrical accessories for different manufacturing and installation requirements.
- Perform installation, cable termination, servicing, maintenance, and recalibration of tools and test equipment following standard procedures.
- Apply safe working practices using appropriate Personal Protective Equipment (PPE) in manufacturing environments.
- Demonstrate clean room discipline, ESD protection practices, and shop floor safety standards in electronics manufacturing industries.

Unit 1: **06**

Tools & Equipment:

- Study of all types of tools used in manufacturing
- Classification, Specification and material of cables: Non-metallic Sheathed Cable, Un-grounded / grounded Power supply cable, metallic Sheathed Cable, Multi-Conductor Cable, Coaxial Cable, Unshielded Twisted Pair Cable, Shielded twisted pair cable, Ribbon Cable, Armored & Unarmored Cable, Twin-Lead Cable, Twin Axial Cable, Optical fiber cable.

Unit 2: **06**

Equipment:

- Study of all equipment required and deployed in manufacturing.
- Study of Connectors and sockets for all types of cables and electrical devices

Unit 3: **06**

Installing & servicing processes:

- Installing & servicing, Identification and termination process, General maintenance of tools/ equipment and recalibration of Test equipment, General safety and common Sense safety.

Unit 4: **06**

PPE (Personal Protective Equipment):

- Usage & benefits of PPE, Electronics Manufacturing Services and Types & usage of Various PPE, Maintenance of PPE.

Unit 5: **06**

Clean Room Environment:

- Do’s and Don’ts and Shop Floor Discipline
- ESD Clothing: What to wear, how to wear

References:

- S. K. Bhattacharya, Electrical Engineering Materials, 4th Edition, Khanna Publishers.
- John Bird, Electrical and Electronic Principles and Technology, 6th Edition, Routledge.
- Paul Scherz and Simon Monk, Practical Electronics for Inventors, 4th Edition, McGraw-Hill Education.
- IEC 61340 Series, Electrostatics – Protection of Electronic Devices from Electrostatic Phenomena, International Electrotechnical Commission (IEC).
- Occupational Safety and Health Administration (OSHA), Personal Protective Equipment (PPE) Standards and Guidelines, OSHA Publications.

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ENVIRONMENTAL STUDIES
BVMT202

Course Outcomes:

After successful completion of this course, learners will be able to:

- 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:

- Gadgil, M., & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
- Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36--37.
- Rao, M.N. & Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
- Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012.Environment. 8th edition. John Wiley & Sons.
- Rosencranz, A., Divan, S., & Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.

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HYDRAULICS AND PNEUMATICS
BVMT203

Course Outcomes:

After successful completion of this course, learners will be able to:

- Explain the principles, characteristics, advantages, and limitations of hydraulic and pneumatic systems.
- Identify and select hydraulic pumps, actuators, valves, pipes, and accessories for industrial applications.
- Describe the working principles and applications of pneumatic compressors, cylinders, valves, air motors, and associated components.
- Interpret hydraulic and pneumatic symbols and analyze basic hydraulic and pneumatic circuits using ISO standards.
- Design and apply simple hydraulic and pneumatic circuits for automation and industrial control applications.

Unit 1: **06**

Introduction to Hydraulics and Pneumatics:

- Need and importance of hydraulic and pneumatic systems, hydrostatics and hydrodynamics, properties of fluids, Pascal's law, continuity equation, Bernoulli's equation, advantages and limitations of hydraulic and pneumatic systems.

Unit 2: **06**

Hydraulic Components and Systems:

- **Hydraulic pumps**: types, construction, working, applications, and selection criteria. Hydraulic system elements including filters, manifolds, receivers, coolers, and connectors.
- **Hydraulic actuators:** types, working, and applications.
- **Hydraulic control valves:** types, symbols, designation, working, and applications.
- **Hydraulic pipes:** types, materials, designations, pressure ratings, and selection criteria. Hydraulic piping layout, concepts, rules, and standards.

Unit 3: **06**

Fundamentals of Pneumatics:

- Introduction to pneumatics, compressible fluid flow, mass flow rate, compressible fluids, types, properties, and industrial applications of pneumatic systems.

Unit 4: **06**

Pneumatic Components:

- **Pneumatic pipes:** types, applications, and properties. Air compressors: reciprocating and rotary compressors, working principles, and selection criteria.
- **Pneumatic cylinders:** types, symbols, cushioning, assemblies, mounting methods, and applications. Pneumatic valves: types, symbols, working principles, applications, and selection.
- **Air motors:** types, working, and applications. Pneumatic accessories including air receivers, filters, pressure regulators, and lubricators. Introduction to solenoid valves, their working principles, and types.

Unit 5: **06**

Hydraulic and Pneumatic Circuits:

- Concept and meaning of hydraulic and pneumatic circuits, ISO symbols for hydraulic and pneumatic components, fundamentals of circuit design, basic hydraulic and pneumatic circuit design, and industrial applications of hydraulic and pneumatic systems.

References:

- S. R. Majumdar, Oil Hydraulic Systems: Principles and Maintenance, Tata McGraw-Hill Education.
- S. R. Majumdar, Pneumatic Systems: Principles and Maintenance, Tata McGraw-Hill Education.
- Andrew Parr, Hydraulics and Pneumatics: A Technician's and Engineer's Guide, 3rd Edition, Butterworth-Heinemann (Elsevier).
- Anthony Esposito, Fluid Power with Applications, 8th Edition, Pearson Education.
- Jagadeesha T., Hydraulics and Pneumatics, I. K. International Publishing House Pvt. Ltd.

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ELECTRICAL MACHINES AND CONTROL SYSTEMS
BVMT204

Course Outcomes:

After successful completion of this course, learners will be able to:

- Explain the construction, operating principles, characteristics, and performance of DC machines.
- Analyze the operation, characteristics, and equivalent circuits of three-phase induction motors.
- Describe the construction, operation, voltage regulation, and performance of synchronous generators and motors.
- Apply the basic concepts of control systems, transfer functions, signal flow graphs, and Mason's Gain Formula in system analysis.
- Identify and analyze the components and controllers used in industrial control systems, including PID controllers and synchro devices.

Unit 1: **06**

D.C. Machines:

- Constructional features of DC machines, principles of operation, EMF equation, voltage build-up phenomenon in DC shunt generators, characteristics of DC series, shunt and compound generators, principle of operation of DC motors, back EMF, speed and torque equations, and characteristics of different types of DC motors.

Unit 2: **06**

A.C. Machines:

- Constructional features of AC machines, concept of rotating magnetic field, principle of operation of three-phase induction motors, torque-slip characteristics, power flow in induction motors, induction motor as a transformer, and equivalent circuit of induction motors.

Unit 3: **06**

Three-Phase Synchronous Machines:

- Constructional features of synchronous machines, EMF equation, armature reaction of synchronous generators, voltage regulation of synchronous generators, phasor diagrams, equivalent circuits of synchronous machines, starting methods, and principle of operation of synchronous motors.

Unit 4: **06**

Introduction to Control Systems:

- Introduction to control systems, open-loop and closed-loop control systems, applications of control systems including temperature control, traffic control, and numerical control, general block diagram of a control system, transfer function, signal flow graph, and Mason's Gain Formula.

Unit 5: **06**

Components of Control Systems:

- Components of control systems, potentiometer, synchro, synchro transmitter and receiver, controllers, two-position controllers, controller preparation and analysis, integrated controllers, and electronic PID controllers.

References:

- D. C. Kulshreshtha, Basic Electrical Engineering, McGraw-Hill Education, 2011.
- J. Nagrath and D. P. Kothari, Basic Electrical Engineering, McGraw-Hill Education.
- T. K. Nagsarkar and M. S. Sukhija, Basic Electrical Engineering, Oxford University Press.
- Gopal M., Control Systems: Principles and Design, 4th Edition, Tata McGraw-Hill Education.
- B. L. Theraja and A. K. Theraja, A Textbook of Electrical Technology (Vol. II: AC & DC Machines), S. Chand & Company.

KALINGA UNIVERSITY
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ON JOB TRAINING/INTERNSHIP/WORKSHOP
BVMT205P

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SEMESTER-03

KALINGA UNIVERSITY
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MATERIAL SCIENCE AND ENGINEERING
BVMT301

Course Outcomes:

- Explain the classification, properties, and applications of engineering materials used in various engineering fields.
- Describe the atomic structure, crystal structure, imperfections, and microstructure of engineering materials.
- Interpret phase diagrams and explain phase transformations and heat treatment processes in metals and alloys.
- Differentiate between metallic, non-metallic, composite, and advanced materials and identify their engineering applications.
- Select appropriate engineering materials based on mechanical properties, design requirements, economic feasibility, environmental sustainability, and societal considerations.

Unit 1: **06**

Introduction to Engineering Materials:

- Introduction to engineering materials, classification of engineering materials, importance of materials in engineering, properties of engineering materials, relationship between structure, properties, and applications, and selection criteria for engineering materials.

Unit 2: **06**

Structure of Materials:

- Atomic structure and bonding in materials, crystal structure, crystal systems, unit cells, imperfections in solids, grain structure, microstructure, and relationship between structure and material properties.

Unit 3: **06**

Phase Diagrams and Phase Transformations:

- Introduction to phase diagrams, Gibbs phase rule, equilibrium diagrams, iron-carbon equilibrium diagram, phase transformations in metals and alloys, cooling curves, heat treatment processes, and their influence on material properties.

Unit 4: **06**

Metallic, Non-Metallic and Advanced Materials:

- Ferrous and non-ferrous metals and alloys, ceramics, polymers, composites, advanced engineering materials, smart materials, nano-materials, biomaterials, functional materials, and applications of advanced materials in engineering.

Unit 5: **06**

Material Selection and Engineering Considerations:

- Material selection criteria, design considerations in material selection, economic aspects of engineering materials, environmental and sustainability issues, recycling of materials, societal impact of material selection, life-cycle considerations, and case studies in engineering material selection.

References:

- William D. Callister Jr. and David G. Rethwisch, Materials Science and Engineering: An Introduction, 10th Edition, John Wiley & Sons.
- V. Raghavan, Materials Science and Engineering: A First Course, 6th Edition, PHI Learning Pvt. Ltd.
- V. D. Kodgire and S. V. Kodgire, Material Science and Metallurgy for Engineers, Everest Publishing House.
- Donald R. Askeland and Wendelin J. Wright, The Science and Engineering of Materials, 7th Edition, Cengage Learning.
- Sidney H. Avner, Introduction to Physical Metallurgy, 2nd Edition, McGraw-Hill Education.

KALINGA UNIVERSITY
RAIPUR INDIA

FAULT ANALYSIS & REPAIR
BVMT302

Course Outcomes:

- Classify and identify faults in electronic systems using systematic troubleshooting techniques.
- Perform fault rectification, module replacement, and preventive maintenance of electronic equipment.
- Analyze and troubleshoot faults in smartphones, air conditioning systems, security systems, and electronically controlled doors.
- Apply hardware and software diagnostic techniques using appropriate testing methods and tools.
- Conduct visual inspections and electrical safety tests, including Earth Continuity and Insulation Resistance Tests, to ensure reliable and safe operation of electronic equipment.

Unit 1: **06**

Fault Classification and Identification:

- Introduction to faults in electronic systems, classification of faults, types of faults, fault identification techniques, causes of faults, and methods of fault diagnosis.

Unit 2: **06**

Fault Rectification and Equipment Maintenance:

- Fault rectification methods, repairing and replacing modules, preventive maintenance, corrective maintenance, maintenance procedures, and safety precautions during servicing.

Unit 3: **06**

Fault Analysis of Electronic Equipment:

- Fault analysis and troubleshooting of smartphones, air conditioning systems, security systems, electronically controlled doors, common faults, diagnostic procedures, and maintenance techniques.

Unit 4: **06**

Hardware and Software Fault Analysis:

- Hardware fault analysis, software fault analysis, hardware and software components, diagnostic tools, testing methods, troubleshooting procedures, fault isolation techniques, system verification, and corrective actions.

Unit 5: **06**

Visual Inspection and Electrical Safety Testing:

- Visual inspection techniques, inspection procedures for electronic equipment, Earth Continuity Test, Insulation Resistance Test, interpretation of test results, electrical safety standards, documentation, and preventive maintenance practices.

References:

- R. S. Khandpur, Troubleshooting Electronic Equipment, 2nd Edition, McGraw-Hill Education.
- Robert L. Boylestad, Electronic Devices and Circuit Theory, 11th Edition, Pearson Education.
- Albert Paul Malvino and David J. Bates, Electronic Principles, 8th Edition, McGraw-Hill Education.
- K. Lal Kishore, Electronic Equipment Maintenance, Pearson Education India.
- IEC 60364 Series, Electrical Installations for Buildings – Inspection, Testing and Safety Requirements, International Electrotechnical Commission (IEC).

KALINGA UNIVERSITY
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APPLIED MECHATRONICS
BVMT303

Course Outcomes:

- Explain the fundamentals, scope, and applications of power electronics and distinguish it from linear electronics.
- Analyze the characteristics and applications of operational amplifiers in different electronic circuits.
- Describe the operation and control of DC–DC converters, including buck, boost, buck-boost, and full-bridge converters.
- Explain the principles and applications of single-phase and three-phase AC–AC converters, cycloconverters, and matrix converters.
- Analyze the operation and performance of thyristor-based phase-controlled rectifiers for single-phase and three-phase power conversion.

Unit 1: **06**

Introduction to Power Electronics:

- Introduction to power electronics, comparison between power electronics and linear electronics, scope of power electronics, applications of power electronic systems in industrial, commercial, and domestic sectors.

Unit 2: **06**

Operational Amplifiers:

- Introduction to operational amplifiers, block diagram representation of a typical operational amplifier, schematic symbol, characteristics of operational amplifiers, ideal operational amplifier, equivalent circuit, ideal voltage transfer characteristics, open-loop configuration, differential amplifier, inverting amplifier, non-inverting amplifier, and operational amplifier with negative feedback.

Unit 3: **06**

DC–DC Converters:

- Introduction to DC–DC converters, control of DC converters, buck converter, boost converter, buck-boost converter, full-bridge DC–DC converter, operating principles, characteristics, and industrial applications.

Unit 4: **06**

AC–AC Converters:

- Single-phase and three-phase AC voltage controllers, control strategies, power factor control, multistage sequence control, single-phase and three-phase cycloconverters, and introduction to matrix converters, operating principles, and applications.

Unit 5: **06**

Phase-Controlled Rectifiers:

- Introduction to phase-controlled rectifiers, thyristor circuits, single-phase converters, three-phase converters, operating principles, performance characteristics, and industrial applications.

References:

- P. S. Bimbhra, Power Electronics, 5th Edition, Khanna Publishers.
- Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, 4th Edition, Pearson Education.
- Ned Mohan, Tore M. Undeland, and William P. Robbins, Power Electronics: Converters, Applications and Design, 3rd Edition, John Wiley & Sons.
- R. S. Sedha, A Textbook of Applied Electronics, S. Chand & Company Ltd.
- Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, 4th Edition, Pearson Education.

KALINGA UNIVERSITY
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PRINCIPLES OF MACHINE TOOLS
BVMT304

Course Outcomes:

- Explain the fundamentals of machine tools and various machining processes used in manufacturing industries.
- Classify machine tools and analyze their kinematic arrangements and motion transmission mechanisms.
- Describe different types of machine tool drives and select suitable drive systems for machining operations.
- Analyze the design of machine tool structures, spindles, and bearing systems for improved machining performance.
- Explain the working principles and applications of conventional and computer-based control systems used in modern machine tools.

Unit 1: **06**

Introduction to Machine Tools and Basic Machining Processes:

- Introduction to machine tools, importance of machine tools in manufacturing, basic machining processes, turning, drilling, milling, shaping, planning, boring, grinding, and machining parameters.

Unit 2: **06**

Classification and Kinematics of Machine Tools:

- Classification of machine tools, constructional features, kinematics of machine tools, types of machine tool motions, speed and feed mechanisms, kinematic chains, and transmission systems.

Unit 3: **06**

Machine Tool Drives:

- Introduction to machine tool drives, mechanical drives, hydraulic drives, pneumatic drives, electrical drives, speed regulation methods, feed drives, and selection of machine tool drives.

Unit 4: **06**

Machine Tool Structures, Spindles and Bearings:

- Design considerations for machine tool structures, machine tool beds and columns, rigidity and vibration, machine tool spindles, spindle design considerations, spindle bearings, types of bearings, lubrication systems, and maintenance of spindles and bearings.

Unit 5: **06**

Machine Tool Control Systems:

- Introduction to machine tool control systems, manual and automatic control systems, numerical control (NC), computer numerical control (CNC), direct numerical control (DNC), adaptive control systems, servo systems, sensors used in machine tools, and applications of modern machine tool control systems.

References:

- G. C. Sen and A. Bhattacharyya, Principles of Machine Tools, 2nd Edition, New Central Book Agency.
- H. N. Gupta, Machine Tools, New Age International Publishers.
- P. N. Rao, Manufacturing Technology – Metal Cutting and Machine Tools, Vol. II, 4th Edition, McGraw-Hill Education.
- Geoffrey Boothroyd and Winston A. Knight, Fundamentals of Machining and Machine Tools, 3rd Edition, CRC Press.
- B. S. Raghuwanshi, Workshop Technology, Vol. II, Dhanpat Rai Publications.

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ON JOB TRAINING/INTERNSHIP/WORKSHOP
BVMT305P

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SEMESTER-04

KALINGA UNIVERSITY
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DIGITAL AND POWER ELECTRONICS
BVMT401

Course Outcomes:

- Explain the principles of digital logic, number systems, logic gates, and combinational logic circuits.
- Apply Boolean algebra, Karnaugh maps, latches, and flip-flops for the analysis and design of digital circuits.
- Analyze the operation, characteristics, and applications of power semiconductor devices used in power electronic systems.
- Explain the operating principles and applications of Cycloconverters in AC power conversion.
- Analyze the performance of voltage source and current source inverters and apply PWM techniques for efficient power conversion.

Unit 1: **06**

Fundamentals of Digital Electronics:

- Logic levels and pulse waveforms, elements and functions of digital logic, digital integrated circuits, number systems and codes, logic gates (AND, OR, NAND, NOR, XOR), propagation delay, power dissipation, noise immunity, fan-in and fan-out, loading considerations, AND-OR logic, universal properties of NAND and NOR gates, half adders, full adders, decoders, encoders, multiplexers, and demultiplexers.

Unit 2: **06**

Boolean Algebra and Sequential Logic Circuits:

- Boolean operations, logic expressions, rules and laws of Boolean algebra, De Morgan's theorems, simplification of Boolean expressions, Karnaugh maps (K-maps), latches, flip-flops, types of flip-flops, flip-flop operations, operating characteristics, and applications of flip-flops.

Unit 3: **06**

Power Semiconductor Devices:

- Introduction to power semiconductor devices, switching devices, diode, SCR, TRIAC, GTO, BJT, MOSFET, IGBT, static and dynamic characteristics, SCR triggering methods, commutation circuits, design of driver circuits, and snubber circuits.

Unit 4: **06**

Cycloconverters:

- Principle of Cycloconverters operation, single-phase to single-phase step-up Cycloconverters, single-phase to single-phase step-down Cycloconverters, operating principles, performance characteristics, and industrial applications.

Unit 5: **06**

Inverters and PWM Techniques:

- Single-phase and three-phase voltage source inverters (120° and 180° conduction modes), voltage and harmonic control, pulse width modulation (PWM) techniques including sinusoidal PWM, modified sinusoidal PWM, multiple PWM, introduction to space vector modulation (SVM), current source inverters, and applications of inverters.

References:

- M. Morris Mano and Michael D. Ciletti, Digital Design, 6th Edition, Pearson Education.
- R. P. Jain, Modern Digital Electronics, 5th Edition, McGraw-Hill Education.
- P. S. Bimbhra, Power Electronics, 5th Edition, Khanna Publishers.
- Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, 4th Edition, Pearson Education.
- Ned Mohan, Tore M. Undeland, and William P. Robbins, Power Electronics: Converters, Applications and Design, 3rd Edition, John Wiley & Sons.

KALINGA UNIVERSITY
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INDUSTRIAL AUTOMATION
BVMT402

Course Outcomes:

- Explain the principles, hierarchy, and components of industrial automation systems used in manufacturing industries.
- Analyze automated identification systems, automated material handling systems, AGVs, and automated storage and retrieval systems.
- Develop PLC ladder programs using logic gates, timers, counters, and control instructions for industrial automation applications.
- Design and implement PLC-based control systems for motor control, process control, conveyor systems, bottle filling, and material handling applications.
- Evaluate the applications of HMI, VFD, SCADA, electro-pneumatic systems, and PLC-based automation in modern manufacturing industries.

Unit 1: **06**

Fundamentals of Industrial Automation:

- Introduction to industrial automation, need and benefits of industrial automation, automation hierarchy, basic components of automation systems, shop floor control, relationship between shop floor control and factory information systems, phases of shop floor control including order release, order scheduling, order progress, factory data collection systems, data input techniques, automated identification methods including barcodes, radio frequency identification (RFID), magnetic stripe, optical character recognition (OCR), and case studies on identification systems.

Unit 2: **06**

Automated Material Handling Systems:

- Introduction to automated material handling systems, Automatic Guided Vehicles (AGVs), driverless trains, AGV pallet trucks, AGV guidance and routing methods, traffic control and safety in AGV systems, on-board vehicle sensing, zone blocking, system management, remote cell stations, central computer control, applications of AGVs, automated storage and retrieval systems (AS/RS), basic components of AS/RS, relay logic, PLC-based automation systems, and case studies on automated material handling equipment.

Unit 3: **06**

Programmable Logic Controllers (PLC):

- Introduction to PLCs, block diagram and internal architecture of PLCs, PLC input/output modules, memory organization, PLC I/O devices, contact and coil programming, digital logic and ladder logic, conversion between logic diagrams and ladder diagrams, ladder programming for logic gates (AND, OR, NOT, NAND, NOR, EX-OR), basic PLC circuits including start-stop, seal-in circuits, forward and reverse motor control with and without interlocking, water level control systems, motor control applications, and relay-based automation.

Unit 4: **06**

PLC Programming and Industrial Applications:

- PLC arithmetic functions including addition, subtraction, multiplication, and division, comparison functions, timer functions, counter functions, skip functions, master control relay, jump instructions, MOVE and block MOVE functions, ladder programming for bottle filling systems, conveyor systems, mixing processes, automatic door control, car parking systems, net counting systems, and process automation applications.

Unit 5: **06**

HMI, SCADA and Industrial Automation Applications:

- Introduction to Human Machine Interface (HMI), Variable Frequency Drives (VFD), Supervisory Control and Data Acquisition (SCADA), SCADA architecture, benefits and applications of SCADA, electro-pneumatic systems, conveyor automation, sorting and packaging systems, gripper movement control, process automation including temperature and pressure control, mixing and blending operations, manufacturing automation, assembly line automation, CNC machine integration with PLCs, and modern industrial automation systems.

References:

- Frank D. Petruzella, Programmable Logic Controllers, 5th Edition, McGraw-Hill Education.
- John W. Webb and Ronald A. Reis, Programmable Logic Controllers: Principles and Applications, 5th Edition, Pearson Education.
- Stenerson, Jon, Industrial Automation and Process Control, Pearson Education.
- Bolton, W., Programmable Logic Controllers, 6th Edition, Newnes (Elsevier).
- Krishna Kant, Computer-Based Industrial Control, 2nd Edition, PHI Learning Pvt. Ltd.

KALINGA UNIVERSITY
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INDUSTRIAL DRIVES AND CONTROLS
BVMT403

Course Outcomes:

- Explain the construction, characteristics, operation, and applications of power semiconductor devices and SCR triggering circuits.
- Analyze the operation and applications of controlled rectifiers, inverters, choppers, SMPS, and UPS used in industrial drive systems.
- Select and apply appropriate industrial motor control devices, contactors, starters, stepper motors, servo motors, and DC drives for automation applications.
- Describe the principles and applications of open-loop and closed-loop control systems used in industrial processes.
- Develop mathematical models of physical systems and evaluate the stability of industrial control systems for engineering applications.

Unit 1: **06**

Power Semiconductor Devices and Triggering Circuits:

- Construction, working principles, characteristics, and applications of SCR, DIAC, TRIAC, UJT, MOSFET, and IGBT. Interpretation of semiconductor device data sheets. V-I characteristics of power semiconductor devices. SCR triggering circuits using resistance (R), resistance-capacitance (RC), and UJT relaxation oscillator triggering methods.

Unit 2: **06**

Power Converters and Industrial Power Supplies:

- Controlled rectifiers including single-phase half-wave and full-wave rectifiers, operating principles and applications. Inverters including series, parallel, and bridge inverters with industrial applications. Choppers including step-up and step-down choppers and their applications. Introduction to Switched Mode Power Supply (SMPS) and Uninterruptible Power Supply (UPS), block diagrams, applications, and troubleshooting techniques.

Unit 3: **06**

Industrial Motor Control Devices and Drives:

- Electrical symbols, wiring diagrams, schematic diagrams, block diagrams, single-line diagrams, and ladder diagrams. Pilot devices including manually operated switches, mechanically operated switches, disconnect switches, contactors, magnetic motor starters, solid-state contactors, manual motor starters, stepper motors, servo motors (AC and DC), brushless DC motors, speed control of DC motors, DC drive systems, characteristics, construction, operation, control methods, and industrial applications.

Unit 4: **06**

Fundamentals of Control Systems:

- Introduction to control systems, open-loop and closed-loop control systems, development of control systems, multivariable control systems, advantages of control systems, control systems used in domestic and industrial appliances, and introduction to feedback control.

Unit 5: **06**

Modeling and Stability of Physical Systems:

- Physical systems, physical and mathematical models, modeling using differential equations, mechanical translational systems, mechanical rotational systems, thermal systems, liquid level systems, analogous systems, concept of stability, relative stability, conditions for stability, and applications of stability analysis in modern industrial control systems.

References:

- Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, 4th Edition, Pearson Education.
- Bimal K. Bose, Modern Power Electronics and AC Drives, Pearson Education.
- K. Ogata, Modern Control Engineering, 5th Edition, Pearson Education.
- Norman S. Nise, Control Systems Engineering, 8th Edition, John Wiley & Sons.
- P. C. Sen, Principles of Electric Machines and Power Electronics, 3rd Edition, John Wiley & Sons.

KALINGA UNIVERSITY
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MICROPROCESSOR
BVMT404

Course Outcomes:

- Explain the architecture, organization, and operation of microprocessors and microcomputer systems with emphasis on the 8085 microprocessor.
- Develop and execute assembly language programs using the 8085 instruction set for arithmetic, logical, and branching operations.
- Analyze timing diagrams and implement memory and input/output interfacing techniques for microprocessor-based systems.
- Apply stack operations, subroutines, and interrupt handling mechanisms in 8085 microprocessor programming.
- Interface programmable peripheral devices and implement data transfer schemes using 8255, 8155, 8259, and 8237 in microprocessor applications.

Unit 1: **06**

Introduction to Microprocessors and Microcomputer Systems:

- Introduction to digital computers, computer languages, single-chip microcomputers, microprocessor architecture, operation of a microprocessor, memory organization, input/output devices, microcomputer systems, architecture of the 8085 microprocessor, 8085-based microcomputer systems, pin details of the 8085 microprocessor, and introduction to the pin diagrams of the 8086 and 8088 microprocessors.

Unit 2: **06**

8085 Instruction Set and Assembly Language Programming:

- Introduction to the 8085 instruction set, instruction classification, instruction formats, writing and execution of simple assembly language programs, instruction timing and operation status, data transfer instructions, arithmetic instructions, branch instructions, looping techniques, arithmetic operations using memory, logical operations, rotate instructions, compare instructions, and programming techniques of the 8085 microprocessor.

Unit 3: **06**

Timing Diagrams and Microprocessor Interfacing:

- Timing diagram techniques, memory read cycle, memory write cycle, opcode fetch cycle with and without wait states, T-state calculations for different instructions, memory interfacing, input/output port interfacing, programmable peripheral interface, memory-mapped I/O, and I/O-mapped I/O.

Unit 4: **06**

Stack, Subroutines and Interrupts:

- Stack organization and operations, subroutines, conditional call and return instructions, advanced subroutine concepts, interrupt structure of the 8085 microprocessor, interrupt handling, interrupt priority, and applications of interrupts.

Unit 5: **06**

Data Transfer Schemes and Peripheral Devices:

- Introduction to data transfer schemes, programmable peripheral interfaces (8255 and 8155), pin details, control register concepts, interrupt-driven input/output, Direct Memory Access (DMA), programmable interrupt controller (8259), DMA controller (8237), and applications of peripheral interface devices.

References:

- Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085, 6th Edition, Penram International Publishing.
- K. Ray and K. M. Bhurchandi, Advanced Microprocessors and Peripherals, 3rd Edition, McGraw-Hill Education.
- Douglas V. Hall, Microprocessors and Interfacing: Programming and Hardware, 2nd Edition, McGraw-Hill Education.
- Ram, Fundamentals of Microprocessors and Microcomputers, 8th Edition, Dhanpat Rai Publications.
- Yu-Cheng Liu and Glenn A. Gibson, Microcomputer Systems: The 8086/8088 Family – Architecture, Programming and Design, 2nd Edition, Prentice Hall.

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ON JOB TRAINING/INTERNSHIP/WORKSHOP
BVMT405P

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SEMESTER-05

KALINGA UNIVERSITY
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MECHATRONICS SYSTEM DESIGN AND ROBOTICS BVMT501

Course Outcomes:

- Explain the concepts, design methodology, and interdisciplinary nature of mechatronics systems.
- Design and integrate mechanical, electrical, electronic, sensing, and control components for mechatronic products.
- Describe robot configurations, components, specifications, and motion control used in industrial robotics.
- Develop basic robot programs and apply robot programming techniques for industrial automation tasks.
- Evaluate the applications of mechatronics and robotics in manufacturing, healthcare, automation, and other modern engineering systems.

Unit 1: **06**

Fundamentals of Mechatronics System Design:

- Introduction to mechatronics, definition and scope of mechatronics, integration of mechanical, electrical, electronics, control, and computer systems, mechatronics system design process, stages of system design including conceptual design, detailed design, prototype development, testing, product development lifecycle, design methodology, problem identification, requirement analysis, conceptualization, prototyping, and case studies of mechatronic systems.

Unit 2: **06**

Mechanical System Integration and Mechatronic Product Design:

- Mechanical design principles, load analysis, material selection, component sizing, integration of mechanical and electrical components, integration of motors, sensors, and actuators, mechanical system optimization, energy efficiency, performance improvement, design of mechatronic products including pick-and-place robots, automatic cameras, car park barriers, car engine management systems, advanced mechatronics applications, condition monitoring sensors, artificial intelligence in mechatronics, fuzzy logic, microsensors, and industrial case studies.

Unit 3: **06**

Fundamentals of Robotics and Robot Components:

- Introduction to robotics, definition and laws of robotics, industrial, service, mobile, autonomous, and collaborative robots, robot configurations including Cartesian, cylindrical, polar, and articulated robots, basic elements of robot systems including manipulators, end effectors, sensors, transducers, actuators, drives, and control systems, robot motions, mechanical joints, robot specifications including work envelope, payload, speed, accuracy, repeatability, and spatial resolution.

Unit 4: **06**

Robot Programming and End Effectors:

- Types of robot end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive grippers, tool end effectors, gripper design considerations, robot programming methods, lead-through programming, robot path programming, motion interpolation, robot programming languages, language structure, variables, constants, motion commands, speed commands, computational operations, monitor mode commands, and robot simulation techniques.

Unit 5: **06**

Industrial Applications of Robotics:

- Applications of robots in manufacturing, material handling, pick-and-place operations, palletizing, spot welding, arc welding, spray painting, die casting, plastic moulding, forging operations, automated assembly, automated inspection, medical robotics, space exploration, domestic robots, intelligent robotic systems, and future trends in robotics and automation.

References:

- W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 7th Edition, Pearson Education.
- Devdas Shetty and Richard A. Kolk, Mechatronics System Design, 2nd Edition, Cengage Learning.
- Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, 3rd Edition, John Wiley & Sons.
- Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 5th Edition, Pearson Education.
- John J. Craig, Introduction to Robotics: Mechanics and Control, 4th Edition, Pearson Education.

KALINGA UNIVERSITY
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MANUFACTURING & QUALITY NORMS
BVMT502

Course Outcomes:

- CO1: Explain manufacturing processes, work instructions, and quality norms followed in electronics manufacturing industries.
- CO2: Perform packing line operations, product identification, labeling, and outgoing quality assurance activities according to industry standards.
- CO3: Apply testing and inspection procedures to evaluate the quality of electronic components and finished products.
- CO4: Implement quality assurance practices using acceptance quality level (AQL), sampling techniques, and acceptance/rejection criteria.
- CO5: Analyze manufacturing defects and apply corrective actions and continuous quality improvement techniques to enhance product quality.

Unit 1: **06**

Manufacturing Operations and Work Instructions:

- Introduction to manufacturing and quality norms, manufacturing practices for different applications, manpower deployment, work instructions, process criticality, sequence of manufacturing operations, operation-wise practical understanding, process documentation, and acceptance and rejection criteria for manufacturing operations.

Unit 2: **06**

Packing Line Operations and Quality Systems:

- Packing line process, packing line operation sequence, importance of packing operations, quality systems, acceptance and rejection criteria during outgoing quality assurance (OQA), assembly of electronic components, inspection and testing of assembled products, labels and barcode scanning, importance of product identification, stages of packing, packaging standards, and acceptance criteria.

Unit 3: **06**

Testing and Quality Inspection:

- Testing procedures for electronic equipment and devices, practical training in testing and inspection, quality inspection methods, operation-wise testing procedures, quality norms, defect identification, acceptance and rejection criteria, and documentation of inspection results.

Unit 4: **06**

Quality Assurance and Sampling Techniques:

- Introduction to quality assurance (QA), acceptance quality level (AQL), sampling techniques, acceptance sampling plans, rejection criteria, statistical sampling methods, inspection procedures, QA documentation, and quality control practices in manufacturing industries.

Unit 5: **06**

Defect Analysis and Continuous Quality Improvement:

- Types of manufacturing defects, defect analysis techniques, root cause analysis, corrective and preventive actions (CAPA), continuous quality improvement, process monitoring, quality audits, documentation, and quality management practices for achieving product reliability.

References:

- Dale H. Besterfield, Quality Control, 9th Edition, Pearson Education.
- Douglas C. Montgomery, Introduction to Statistical Quality Control, 8th Edition, John Wiley & Sons.
- Amitava Mitra, Fundamentals of Quality Control and Improvement, 4th Edition, John Wiley & Sons.
- P. N. Mukherjee, Total Quality Management, PHI Learning Pvt. Ltd.
- ISO 9001:2015, Quality Management Systems – Requirements, International Organization for Standardization (ISO).

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FLUID POWER ENGINEERING
BVMT503

Course Outcomes:

- Explain the principles, components, and operating characteristics of hydraulic and pneumatic systems used in industrial applications.
- Design and analyze hydraulic circuits for industrial automation and material handling applications.
- Develop pneumatic circuits and evaluate their performance in automation, robotics, and process control systems.
- Apply electro-hydraulic and electro-pneumatic control techniques using electrical, electronic, and PLC-based systems.
- Evaluate fluid power systems with respect to energy efficiency, safety, maintenance, and modern mechatronics applications.

Unit 1: **06**

Fundamentals of Fluid Power Systems:

- Introduction to fluid power engineering, definition and applications of hydraulic and pneumatic systems, advantages and limitations of fluid power systems, properties of fluids including viscosity, density, pressure, capillarity, and surface tension, Pascal's law, Bernoulli's principle, fluid flow, laminar and turbulent flow, continuity equation, hydraulic and pneumatic components, hydraulic pumps, pneumatic compressors, air preparation units (FRL), hydraulic and pneumatic actuators, control valves, accumulators, seals, symbols, and comparison of hydraulic and pneumatic systems.

Unit 2: **06**

Hydraulic Systems and Circuit Design:

- Hydraulic pumps, hydraulic cylinders, hydraulic motors, pressure control valves, flow control valves, directional control valves, actuation mechanisms, hydraulic circuit design, meter-in, meter-out, bleed-off circuits, lifting systems, clamping devices, unloading circuits, interlocking circuits, maintenance of hydraulic systems, contamination control, leakage prevention, and industrial applications.

Unit 3: **06**

Pneumatic Systems and Circuit Design:

- Pneumatic compressors, pneumatic cylinders, pneumatic valves, twin pressure valves, shuttle valves, quick exhaust valves, flow control valves, time delay valves, direct and indirect control circuits, cascade systems, pneumatic circuit design, pick-and-place systems, robotics, conveyor systems, maintenance of pneumatic systems, air quality management, pressure losses, preventive maintenance, and industrial applications.

Unit 4: **06**

Electro-Hydraulic and Electro-Pneumatic Systems:

- Introduction to electro-fluid systems, electrical control in fluid power systems, solenoids, relays, sensors, electro-hydraulic circuits, electro-pneumatic circuits, control of double-acting cylinders, logic control (AND and OR), timer and counter applications, PLC integration, microcontroller-based fluid power systems, and industrial automation applications.

Unit 5: **06**

Fluid Power Applications, Energy Efficiency and Safety:

- Fluid power applications in mechatronics, CNC machines, automobile systems, packaging machines, material handling systems, fluid power simulation software, energy conservation in fluid power systems, servo valves, proportional control valves, hydraulic and pneumatic system safety, hazards, preventive measures, best industrial practices, and sustainable fluid power systems.

References:

- Anthony Esposito, Fluid Power with Applications, 7th Edition, Pearson Education.
- S. R. Majumdar, Oil Hydraulic Systems: Principles and Maintenance, McGraw-Hill Education.
- Andrew Parr, Hydraulics and Pneumatics: A Technician's and Engineer's Guide, 3rd Edition, Butterworth-Heinemann.
- Peter Rohner, Fluid Power Logic Circuit Design, Macmillan Education.
- W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 7th Edition, Pearson Education.

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SENSORS AND TRANSDUCERS
BVMT504

Course Outcomes:

- Explain the principles of industrial measurement systems, sensors, transducers, and their static and dynamic characteristics.
- Select and apply suitable displacement sensors and transducers for industrial measurement applications.
- Analyze velocity, speed, vibration, and acceleration measurement techniques using various industrial sensors.
- Evaluate force, torque, pressure, and temperature measurement methods using appropriate transducers and instrumentation.
- Select suitable sensors and measuring instruments for industrial process control, monitoring, and automation applications.

Unit 1: **06**

Introduction to Measurement Systems:

- Measurement and measurement systems, industrial measuring parameters and their units, definitions of sensors and transducers, classification of transducers, static and dynamic characteristics, selection criteria, and importance of sensors and transducers in industrial measurement.

Unit 2: **06**

Displacement Measurement:

- Displacement measurement using resistive transducers including potentiometers and strain gauges, inductive transducers including LVDT and eddy current sensors, capacitive transducers including capacitance pickups and differential capacitive transducers, piezoelectric transducers, ultrasonic transducers, Hall effect transducers, and optical transducers.

Unit 3: **06**

Velocity, Speed, Vibration and Acceleration Measurement:

- Velocity and speed measurement using electromagnetic tachometers, photoelectric tachometers, toothed rotor variable reluctance tachometers, magnetic pickups, encoders, photoelectric pickups, stroboscopes, and shaft speed measurement techniques. Vibration and acceleration measurement using eddy current transducers, piezoelectric transducers, seismic transducers, potentiometric accelerometers, LVDT accelerometers, and piezoelectric accelerometers.

Unit 4: **06**

Force and Torque Measurement:

- Basic methods of force measurement, elastic force transducers, strain gauge load cells, piezoelectric force transducers, vibrating wire force transducers, strain gauge torque meters, inductive torque meters, magnetostrictive transducers, torsion bar dynamometers, servo-controlled and absorption dynamometers, instantaneous power measurement, and alternator power measurement.

Unit 5: **06**

Pressure and Temperature Measurement:

- Pressure measurement including pressure definitions, pressure scales, standards, working principles, types of pressure sensors, materials, design criteria, manometers, elastic pressure sensors, secondary pressure sensors, differential pressure sensors, force balance type, motion balance type, capacitive (delta cell), ring balance, vibrating cylinder type, high-pressure gauges, vacuum gauges, dead weight testers, and vacuum gauge testers.
- Temperature measurement including temperature scales, standards and units, classification of temperature sensors, bimetallic thermometers, filled system thermometers, SAMA classifications, resistance temperature detectors (RTDs), thermistors, thermocouples, thermocouple tables, lead wire compensation, cold junction compensation techniques, thermowells, thermopiles, pyrometers, and temperature IC sensors such as AD590 and LM35.

References:

- D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall of India.
- K. Sawhney, A Course in Mechanical Measurements and Instrumentation, Dhanpat Rai Publications.
- Ernest O. Doebelin and Dhanesh N. Manik, Measurement Systems: Application and Design, 6th Edition, McGraw-Hill Education.
- R. K. Rajput, Electronic Measurements and Instrumentation, S. Chand & Company Ltd.
- Bela G. Lipták (Ed.), Instrument Engineers' Handbook: Process Measurement and Analysis, 4th Edition, CRC Press.

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BVMT505P

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SEMESTER-06

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MANUFACTURING AUTOMATION AND ERGONOMICS BVMT601

Course Outcomes:

- Explain the concepts, principles, and strategies of manufacturing automation and their applications in modern industries.
- Analyze automated flow lines, assembly systems, line balancing techniques, and Industry 4.0 technologies for efficient manufacturing.
- Describe advanced manufacturing technologies, including nanotechnology, AFM, SEM, TEM, and advanced electronic packaging.
- Explain the construction, classification, and industrial applications of robotic systems and manipulators used in manufacturing automation.
- Apply ergonomic principles and human-machine interaction concepts to improve workplace safety, productivity, and manufacturing efficiency.

Unit 1: **06**

Introduction to Manufacturing Automation:

- Introduction to manufacturing automation, types and strategies of automation, principles of manufacturing automation, pneumatic and hydraulic components and circuits, automation in machine tools, mechanical feeding systems, automatic tool changing systems, machine tool control, transfer automation, and the role of automation in product realization.

Unit 2: **06**

Automated Flow Lines and Assembly Systems:

- Automated flow lines, methods of automation, mechanical buffer storage, storage control functions, design and fabrication considerations, assembly processes, assembly systems, assembly line balancing, methods of line balancing, techniques for improving line balance, flexible assembly lines, and Industry 4.0 technologies for improving manufacturing efficiency and productivity.

Unit 3: **06**

Advanced Manufacturing Technologies:

- Advancements in manufacturing, nanotechnology and its industrial applications, Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), advanced electronic packaging technologies, smart manufacturing, and emerging trends in advanced production systems.

Unit 4: **06**

Industrial Robotics:

- Introduction to robotics, classification of robots, robot work envelope, manipulators, electronic and pneumatic manipulators, end effectors, robot control systems, robot configurations, industrial robot applications, and the role of robotics in automated manufacturing.

Unit 5: **06**

Ergonomics and Human-Machine Interaction:

- Introduction to ergonomics, evolution and definitions of ergonomics, scope of ergonomics, principles and aspects of ergonomics, application areas of ergonomics, workplace design, human factors engineering, man-machine interaction, occupational safety, productivity improvement, and ergonomic considerations in manufacturing industries.

References:

- Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 5th Edition, Pearson Education.
- Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, 8th Edition, Pearson Education.
- R. S. Khurmi and J. K. Gupta, Industrial Engineering and Production Management, S. Chand & Company Ltd.
- Jan Dul and Bernard Weerdmeester, Ergonomics for Beginners: A Quick Reference Guide, 3rd Edition, CRC Press.
- W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 7th Edition, Pearson Education.

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INDUSTRY 4.0
BVMT602

Course Outcomes:

- Explain the concepts, principles, benefits, and implementation strategies of Industry 4.0 and smart manufacturing.
- Analyze the role of Industry 4.0 technologies such as IoT, cloud computing, robotics, virtual reality, augmented reality, and additive manufacturing in modern industries.
- Describe the architecture, design, and applications of IoT systems for industrial automation and smart factories.
- Evaluate Machine-to-Machine (M2M) communication, software-defined networking, and industrial communication systems used in connected manufacturing environments.
- Apply Artificial Intelligence concepts and intelligent agent models to solve problems in industrial automation, robotics, and smart manufacturing.

Unit 1: **06**

Introduction to Industry 4.0:

- Introduction to Industry 4.0, definition and evolution of Industry 4.0, benefits of Industry 4.0, industrial revolutions and future perspectives, digital transformation of industries, principles of the smart factory, Industry 4.0 implementation strategies, challenges, risks, and opportunities in smart manufacturing.

Unit 2: **06**

Industry 4.0 Technologies:

- Key technologies of Industry 4.0, Internet of Things (IoT) technologies for industrial applications, human-machine interaction, advanced robotics, additive manufacturing (3D printing), lean manufacturing, touch interfaces, virtual reality (VR), augmented reality (AR), cloud computing, and applications of digital technologies in smart industries.

Unit 3: **06**

Internet of Things (IoT):

- Introduction to the Internet of Things, definition and characteristics of IoT, physical design of IoT, logical design of IoT, functional blocks of IoT, IoT architecture, communication models, sensors and actuators, IoT devices, and industrial IoT applications.

Unit 4: **06**

IoT, Machine-to-Machine (M2M) Communication and Software-Defined Networking:

- Machine-to-Machine (M2M) communication, architecture of M2M systems, comparison between IoT and M2M, software-defined networking (SDN), industrial communication systems, connected devices, industrial networking, and applications in smart manufacturing and industrial automation.

Unit 5: **06**

Artificial Intelligence in Industry 4.0:

- Introduction to Artificial Intelligence (AI), foundations and scope of AI, problems and approaches in AI, intelligent agents, reactive agents, deliberative agents, goal-driven agents, utility-driven agents, learning agents, AI applications in manufacturing, predictive maintenance, quality control, robotics, and intelligent industrial systems.

References:

- Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress.
- Christoph Jan Bartodziej, The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics, Springer.
- Vijay Madisetti and Arshdeep Bahga, Internet of Things: A Hands-on Approach, Universities Press.
- Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 4th Edition, Pearson Education.
- Raj Kamal, Internet of Things: Architecture and Design Principles, 2nd Edition, McGraw-Hill Education.

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UPS AND INVERTER TECHNICIAN
BVMT603

Course Outcomes:

- Explain the construction, operation, and applications of rectifiers, inverters, and UPS systems.
- Analyze the operation of inverter circuits, oscillators, battery charging circuits, filters, and PWM techniques.
- Design basic DC-to-AC inverter circuits and evaluate their performance for different applications.
- Install, operate, and select suitable UPS and inverter systems based on load requirements and technical specifications.
- Perform testing, troubleshooting, maintenance, and fault diagnosis of UPS and inverter systems while following standard safety practices.

Unit 1: **06**

Introduction to Inverters and Rectifiers:

- Introduction to inverters, applications of inverters, block diagram of an inverter, introduction to rectifiers, types of rectifiers, working principles of half-wave and full-wave rectifiers, and applications of rectifier circuits.

Unit 2: **06**

Working Principles of Inverter Circuits:

- Peak Inverse Voltage (PIV) of diodes, filters used in rectifier circuits, battery charger circuits, inverter oscillators, types of oscillators, square wave generators, pulse width modulation (PWM), and the role of PWM in inverter operation.

Unit 3: **06**

Inverter Design and DC–AC Conversion:

- Principles of DC-to-AC conversion, inverter design, inverter components, switching techniques, output waveform generation, efficiency considerations, design of inverter circuits, and applications of DC-to-AC converters.

Unit 4: **06**

UPS Systems and Installation:

- Pulse Width Modulation (PWM) based UPS circuits, working principle of UPS, UPS specifications, block diagram and operation of UPS, installation procedures, safety precautions, load calculation, selection of suitable inverter and UPS systems, and maintenance practices.

Unit 5: **06**

Testing, Troubleshooting and Maintenance of UPS and Inverter Systems:

- Testing procedures for inverter and UPS systems, troubleshooting techniques, fault diagnosis, battery maintenance, preventive maintenance, performance evaluation, efficiency testing, safety practices, and applications of UPS and inverter systems in domestic, commercial, and industrial environments.

References:

- Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, 4th Edition, Pearson Education.
- P. S. Bimbhra, Power Electronics, 5th Edition, Khanna Publishers.
- M. D. Singh and K. B. Khanchandani, Power Electronics, 2nd Edition, McGraw-Hill Education.
- B. K. Bose, Modern Power Electronics and AC Drives, Pearson Education.
- Ned Mohan, Tore M. Undeland, and William P. Robbins, Power Electronics: Converters, Applications and Design, 3rd Edition, John Wiley & Sons.

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ENTREPRENEURSHIP DEVELOPMENT
BVMT604

Course Outcomes:

- Explain the concepts, characteristics, and importance of entrepreneurship and Entrepreneurship Development Programmes (EDPs).
- Identify business opportunities and prepare strategies for project selection, financing, and enterprise establishment.
- Develop business plans and understand the procedures for establishing and managing small business enterprises.
- Analyze the role of financial and governmental institutions in promoting entrepreneurship and supporting small businesses.
- Prepare project reports and evaluate entrepreneurial challenges using practical case studies and business planning techniques.

Unit 1: **06**

Introduction to Entrepreneurship and Entrepreneurship Development Programme:

- Concept of entrepreneur and entrepreneurship, definition, characteristics and traits of entrepreneurs, classification of entrepreneurs, women entrepreneurs, role of entrepreneurs in economic development, entrepreneurship in India, concept of Entrepreneurship Development Programme (EDP), need for entrepreneurial training, phases of EDP, curriculum and contents of training programmes, support systems, target groups, and institutions conducting EDPs in India.

Unit 2: **06**

Project Identification and Entrepreneurial Finance:

- Business opportunity identification, promotion of a business venture, opportunity analysis, project identification and selection, analysis of external environment including economic, social, technological, and competitive factors, legal requirements for establishing a new enterprise, project financing, term loans, bridge finance, venture capital, government financial assistance, and procedures for approaching financial institutions for loans.

Unit 3: **06**

Small Business Enterprise Development:

- Concept of small business enterprises, identification of business opportunities in different sectors, selection of suitable business opportunities, procedures and formalities for establishing small business enterprises, registration requirements, and challenges in setting up new ventures.

Unit 4: **06**

Institutional Support for Entrepreneurship:

- Role and functions of institutions supporting entrepreneurship, Entrepreneurship Development Institute of India (EDII), Small Industries Development Organization (SIDO), National Small Industries Corporation (NSIC), National Institute for Entrepreneurship and Small Business Development (NIESBUD), support schemes for small enterprises, causes of sickness in small business enterprises, and remedial measures.

Unit 5: **06**

Project Formulation and Entrepreneurial Case Studies:

- Meaning and significance of project reports, contents of a project report, project formulation, planning commission guidelines for preparing project reports, preparation of project reports for small business enterprises, problems faced by entrepreneurs, entrepreneurial success and failure factors, and case studies of successful entrepreneurs.

References:

- Vasant Desai, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House.
- S. S. Khanka, Entrepreneurial Development, S. Chand & Company Ltd.
- Robert D. Hisrich, Michael P. Peters, and Dean A. Shepherd, Entrepreneurship, 11th Edition, McGraw-Hill Education.
- Poornima M. Charantimath, Entrepreneurship Development and Small Business Enterprises, Pearson Education.
- David H. Holt, Entrepreneurship: New Venture Creation, Prentice Hall of India.

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