

SCCA9501	INDUSTRY 4.0	L	T	P	Credits	Total Marks
		2	0	0	2	100

UNIT 1 ADVANCED TECHNOLOGY AND MATERIALS**9 Hrs.**

Advanced electro-optical sensing technology-active, passive multi-spectral and hyper spectral imaging; electronic beam steering; vacuum technology, surface and coating technology, health care technology, Nanotechnology- Nanomechanics, Nano optoelectronics; energy storage technology-next generation Li-based Batteries, Hydrogen storage, solar photovoltaic's, Flexible electronics. Intellectual Property Rights - case studies governing/pertaining to Materials/Technology.

UNIT 2 ADVANCEMENTS IN SUSTAINABLE BUILT ENVIRONMENT**9 Hrs.**

Introduction - Technological developments in Architectural, Engineering and Construction (AEC) - Building Information Modelling (BIM) using Cloud computing technology and Internet of things (IoT) - Unmanned Aerial Vehicles, sensors – Additive manufacturing in construction – Concrete 3D printing - Materials used - Lightweight and functionally graded structures - Net Zero Energy buildings, Bioswales, Biofiltration pond, Ecosan systems- Recent developments in Waste water Management, Air pollution control, waste disposal, public health issues-improving water management in surface and overhead irrigation-Integration of energy, water and environmental systems for a sustainable development.

UNIT 3 SMART MANUFACTURING**9 Hrs.**

Smart factories and interconnection, Smart Manufacturing - automation systems, Additive Manufacturing, Smart grids, Micro Electro Mechanical Systems (MEMS), Stealth technology, Metal Finishing, Self-propelled vehicles, e mobility, Green fuels, drones - unmanned aerial vehicles(UAVs), aerodynamics. Robotic Automation and Collaborative Robots - Augmented reality and haptics, engineering cybernetics and artificial intelligence (AI), Disruptive Technologies - Frugal Innovations - Intellectual Property Rights (IPR): Case Studies.

UNIT 4 SMART WORLD**9 Hrs.**

Smart Sensors and IIOT, Smart grid, Hybrid renewable energy systems, Electronics in Smart city, Integration of Sensors in Robots and Artificial Intelligence, 5G Technology, Communication protocols, Human-Machine Interaction, Virtual Reality, Quantum Computing: Changing trends in transistor technology: Processor, Intellectual Property Rights- Case Studies.

UNIT 5 CYBER PHYSICAL SYSTEMS**9 Hrs.**

Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, healthcare and human computer interactions, Industrial Artificial Intelligence, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Transportation, Intellectual Property Rights (IPR) : CaseStudies.

Max. 45 Hrs.**TEXT / REFERENCE BOOKS**

1. William D. Callister, "Materials Science and Engineering, An Introduction, John Wiley and Sons Inc. Singapore, 2001.
2. V. Raghavan, "Physical Metallurgy: Principle and Practice, Prentice Hall India Pvt Ltd, 2006.
3. FlavioCraveiro, Jose Pinto Duarte, Helena Bartolo and Paulo Jorge Bartolo, "Additive manufacturing as an enabling technology for digital construction: A perspective on Construction 4.0", Automation in Construction, Vol. 103, pp. 251-267, 2019.
4. Klaus Schwab, "Fourth Industrial Revolution", Random House USA Inc, New York, USA, 2017.
5. Oliver Grunow, "SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies", Studylab Publications, 2016
6. Alasdair Gilchrist, "INDUSTRY 4.0: Industrial Internet of Things", Apress, 2016.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A: 5 Questions of 6 Marks each – No choice****30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SECA5302	RTOS PROGRAMMING	L	T	P	Credits	TotalMarks
		3	0	0	3	100

COURSE OBJECTIVES

- To learn about the fundamental difference between general purpose and real time operating systems.
- To learn about the scheduling algorithms used in RTOS.
- To learn about the porting and configuration of RTOS to different hardware targets.
- To learn programming with RTOS.

UNIT 1 INTRODUCTION AND INTERNALS**9Hrs.**

Introduction to Real-Time Systems, Classification of real time systems, Difference between GPOS and RTOS- Real Time Kernels - RTOS Architecture- Features of RTOS- POSIX-RT standard

UNIT 2 PERFORMANCE METRICS AND SCHEDULING ALGORITHMS**9Hrs.**

Performance Metrics of RTOS, Task Specifications-Task state - Real Time Scheduling algorithms: Cyclic executive, Rate monotonic, IRIS and Least laxity scheduling- Schedulability Analysis.

UNIT 3 RESOURCE SHARING FOR REAL TIME TASKS**9Hrs.**

Resource sharing among tasks- Priority inversion Problem- Priority inheritance and Priority ceiling Protocols – Features of commercial and open source real time operating systems: Vxworks, QNX, Micrium OS, RT Linux and FreeRTOS

UNIT 4 APPLICATION PROGRAMMING USING RTOS**9Hrs.**

Task synchronization using semaphores, Intertask communication: message queues and pipes, Remote procedure call- Timers and Interrupts-Memory management and I/O management.

UNIT 5 RTOS IMAGE BUILDING FOR DIFFERENT TARGET PLATFORMS**9Hrs.**

Porting of RTOS, Configuring RTOS for minimizing RAM consumption and increasing Throughput- Building RTOS Image for Target platforms

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Explain types of real time systems and summarize the issues in real time computing
- CO2 - Demonstrate real-time scheduling and schedulability analysis, including clock-driven and priority-driven scheduling algorithms.
- CO3 - Analyze the situation of fault occurrence and will be able to apply solutions accordingly.
- CO4 - Demonstrate porting of RTOS to embedded hardware target platforms.
- CO5 - Develop and implement real time applications using RTOS software.
- CO6 - Attain improved employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

TEXT / REFERENCE BOOKS

1. Jane W. S Liu, "Real Time Systems" Pearson Higher Education, 3rd Edition, 2000.
2. Raj Kamal, "Embedded Systems- Architecture, Programming and Design" Tata McGraw Hill, 2nd Edition, 2014.
3. Jean J. Labrosse, "Micro C/OS-II: The real time kernel" CMP Books, 2nd Edition, 2015.
4. Warren Gay, "Beginning STM32: Developing with FreeRTOS", Apress, 1st Edition, 2018.
5. Richard Barry, "Mastering the FreeRTOS: Real Time Kernel", Real Time Engineers Ltd, 1st Edition, 2016.
6. David E. Simon, "An Embedded Software Primer", Pearson Education Asia Publication,
7. Philip. A Laplante, "Real Time System Design and Analysis", Prentice Hall of India, 3rd Edition, 2006.
8. Li Q, Yao C, "Real-Time Concepts for Embedded Systems", CMP Books, 1st Edition, 2003.
9. Doug Abbott, "Linux for Embedded and Real-time Applications", Newnes, 3rd Edition, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SECA7022	ADVANCED DIGITAL IMAGE PROCESSING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To develop a theoretical foundation of image processing techniques.
- To understand techniques and algorithms to segment / classify/ represent the image.
- To provide analytic skills to process the images with applications.

UNIT 1 DIGITAL IMAGE FUNDAMENTALS**9 Hrs.**

Elements of Visual Perception; Image Sensing and Acquisition; Image Sampling and Quantization; Basic Relationships between Pixels; Monochromatic Vision Models; Colour Vision Models; Colour Fundamentals; Colour Models; Conversion of Colour Models; Colour Transformations.

UNIT 2 ENHANCEMENT AND RESTORATION**9 Hrs.**

Introduction; Point Processing - Image Negatives, Log transformations, Power Law Transformations, Piecewise-Linear Transformation Functions; Arithmetic/Logic Operations - Image Subtraction, Image Averaging; Histogram Processing - Histogram Equalization, Histogram Matching; Spatial filtering - Smoothing, Sharpening; Smoothing Frequency Domain Filters - Ideal Low Pass, Butterworth Low Pass, Gaussian Low Pass; Sharpening Frequency Domain Filters - Ideal High Pass, Butterworth High Pass, Gaussian High Pass; Model of Image Degradation/Restoration Process; Noise Models; Inverse Filtering; Geometric Transformations.

UNIT 3 IMAGE ANALYSIS AND REPRESENTATION**9 Hrs.**

Introduction; Image Segmentation - Point, Line, Edge, Boundary Detection; Colour Image Segmentation; Thresholding- Basic Global Thresholding, Multiple Thresholding, Variable Thresholding; Region Based Segmentation; Representation: Chain codes, Signatures, Boundary segments, Skeletons, Description: Boundary Descriptors, Regional Descriptors.

UNIT 4 MORPHOLOGICAL PROCESSING AND COMPRESSION**9 Hrs.**

Morphological Image Processing - Logic Operations involving Binary Images; Dilation and Erosion; Opening and Closing; Hit or Miss Transform, Basic Morphological Algorithms - Boundary Extraction, Region Filling, Thickening, Thinning; Image Compression - Compression Model, Huffman Coding, Arithmetic Coding.

UNIT 5 CLASSIFICATION AND APPLICATIONS**9 Hrs.**

Object Recognition and Classification, Statistical classification, Structural /Syntactic Classification, 3D Image Processing, 3D Visualization; Surface rendering, Volume rendering; Applications: Motion Analysis, Image Fusion, Image Classification.

Max.45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Understand the fundamentals of Digital Image Processing.
- CO2 - Know the Image Enhancement in the Spatial & Frequency Domain and model the noises and restoration.
- CO3 - Analyze various segmentation and representation techniques.
- CO4 - Analyze various morphological algorithms and compression techniques.
- CO5 - Understand the various classification techniques.
- CO6 - Apply classification algorithms for various applications.

TEXT / REFERENCE BOOKS

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson, 3rd Edition, 2018.
2. Anil K. Jain, "Fundamentals of Digital Image Processing", PHI Learning Private Limited, New Delhi, 2002.
3. John C. Russ, "The Image Processing Handbook", CRC Press, Taylor & Francis Group, 6th Edition, 2011.
4. Geoff Dougherty, "Digital Image Processing for Medical Applications", Cambridge University Press, 2009.
5. William K. Pratt, "Digital Image Processing", John Wiley & Sons, 4th Edition, 2007.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**

SECA6302	RTOS PROGRAMMING LAB	L	T	P	Credits	Total Marks
		0	0	6	2	100

COURSE OBJECTIVES

- To understand the fundamentals of real time systems and its development.
- To acquire knowledge on real time operating systems.
- To understand the design methodologies of real time embedded systems
- To understand the basics of cloud computing technology.

SUGGESTED LIST OF EXPERIMENTS

- 1 Analysis of real time scheduling algorithms using Cheddar Tool.
- 2 Real-time message queues, semaphores, and mutexs.
- 3 Task management and Thread management in freeRTOS.
- 4 RTOS Porting for hardware platforms.
- 5 Development of simple real time embedded applications with freeRTOS.
- 6 Real time PID controller.
- 7 Electronic control unit (ECU).
- 8 Video accelerator.
- 9 Working with Cloud platforms.
- 10 Real time IoT applications using cloud platforms

COURSE OUTCOMES

On completion of the course, the students will be able to

- CO1 - Gain adequate understanding of the software architecture of real time embedded systems.
- CO2 - Develop simple applications for Process Management, Synchronization Techniques, Message Passing, Mutex, etc., using FreeRTOS.
- CO3 - Demonstrate the concept of real-time programming using tasks and context switching.
- CO4 - Demonstrate how storage and virtualization are used in the cloud platform and apply this in practice.
- CO5 - Suggest relevant cloud computing solutions according to the applications.
- CO6 - Apply the fundamental principles of multi-tier web applications and services in a cloud environment.

SECA7032	ADVANCED ROBOTICS AND AUTOMATION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To introduce the functional elements of a ROBOT.
- To understand the concept of kinematics.
- To comprehend the concepts of robot arm dynamics.
- To study and analyze various assembly and inspection procedures.
- To illustrate the applications of Robot in different fields.

UNIT 1 INTRODUCTION**9 Hrs.**

Geometric configuration of robots - Asimov's laws of robotics - work volume. Need for Automation - types of automation - fixed, programmable and flexible automation. Manipulators - drive systems - internal and external sensors - end effectors - control systems - robot programming languages and applications - Introduction to robotic vision system.

UNIT 2 ROBOT ARM KINEMATICS**9 Hrs.**

Direct and Inverse Kinematics - rotation matrices - composite rotation matrices - Euler angle representation -homogeneous transformation – DenavitHattenberg representation and various arm configurations.

UNIT 3 ROBOT ARM DYNAMICS**9 Hrs.**

Lagrange - Euler formulation, joint velocities - kinetic energy - potential energy and motion equations – generalized D'Alembert equations of motion.

UNIT 4 ROBOT APPLICATIONS**9 Hrs.**

Material Transfer & Machine Loading / Unloading. General Consideration in robot material handling transfer applications – Machine loading and unloading. Processing Operations, Spot welding – Continuous arc welding - spray coating – other processing operations using robots.

UNIT 5: ASSEMBLY AND INSPECTION: Assembly and robotic assembly automation – Parts presentation methods – assembly operation – Compliance and the Remote Centre Compliance(RCC) device – Assembly system Configurations – Adaptable, Programmable assembly system – Designing for robotic assembly – Inspection automation.

UNIT 5 UNDERWATER ROBOTICS AND HUMANOIDS**9 Hrs.**

Robotics in Water: Basics Representation of Underwater Robot - Types and Classification of Underwater Robotics. Control System and Types of Control Systems in Underwater Robotics - Sensors Connected with the Underwater Robotics - Introduction to Underwater Manipulators - Introduction to Hydraulics on Underwater Vehicles - Applications of Underwater Vehicles. Humanoids: Wheeled and legged, Legged locomotion and balance, Arm movement, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound and tactile sensing.

Max. 45 Hrs.**COURSE OUTCOMES**

On completion of the course, student will be able to

- CO1 - Recall and recollect the basic concept of robotics.
- CO2 - Understand, develop different robot arm configurations based on kinematic techniques.
- CO3 - Evaluate different robot arm models based on manipulator Dynamics.
- CO4 - Analyze different industrial processing applications of Robots.
- CO5 - Identify the need for underwater and humanoid robots.
- CO6 - Assess different robot sensor systems for underwater autonomous and humanoid robots.

TEXT / REFERENCE BOOKS

1. John J.Craig, "Introduction to Robotics Mechanics and Control", 3rd edition, Pearson Education, 2009.
2. AshitavaGhoshal, "Robotics-Fundamental Concepts and Analysis", Oxford University Press, 6th impression, 2010.
3. Deb S R.andDebS., "Robotics Technology and Flexible Automation", Tata McGraw Hill Education Pvt. Ltd, 2010.
4. Saha S.K., "Introduction to Robotics", Tata McGraw Hill Education Pvt. Ltd, 2010.
5. K.S.Fu, R.C.Gonzalez, CSG. Lee, "Robotics control, sensing, vision and Intelligence", McGraw Hill Education Pvt. Ltd., 2013.
6. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering: An Integrated Approach, PHI Learning", New Delhi, 2009.
7. Mikell P Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, 2015.
8. GianlucaAntonelli, —Underwater RobotsII, Springer, 2014.
9. Roland Siegwart, Illah Reza Nourbakhsh, DavideScaramuzza," Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2011.
10. RiadhSiaer, "The future of Humanoid Robots- Research and applications", Intech Publications, 2012.

SECA7043	AUTONOMOUS DRONE TECHNOLOGY	L	T	P	Credits	Total Marks
		3	1	0	3	100

COURSE OBJECTIVES

- To introduce anatomy of Drones and their types.
- To Familiarize the Student's with aerodynamics of drones.
- To Understand the configuration of flight controllers and other systems in drones
- To understand the fundamentals of autonomous navigation
- To learn the applications of computer vision and AI in autonomous drones.

UNIT I ANATOMY OF DRONE**9 Hrs**

Drones-Definition and Classifications--Anatomy of Drone - Mechanical Structures, Flight Controller, Sensors and Actuators, Electronic Speed Controller, Brushless Motors-Communication Systems-Batteries and Power supply unit

UNIT II AERODYNAMICS AND STABILITY**9 Hrs**

Forces of flight, Principal axes and rotation of aerial systems - Longitudinal axis, Lateral(transverse) axis and Perpendicular axis, Equilibrium, Stability - Stable system, Unstable system and Neutrally stable system, Control — Roll, Pitch, Yaw and Throttle.

UNIT III DESIGN OF GROUND CONTROLLED DRONES**9 Hrs**

Standards and Legal Restrictions for Drones - Frame type selection - Configuring Drones Compass calibration, Access calibration, Radio calibration, Flight mode calibration and Failsafe calibration –Case study- Drones for Aerial photography, Mapping and Surveying.

UNIT IV AUTONOMOUS NAVIGATION AND POSITIONING**9 Hrs**

GPS/GNSS receivers, Inertial Navigation Systems (INS), LIDAR scanners, Ultrasonic sensors and visual camera - Simultaneous Location and Mapping-(SLAM)- Mission Planner.

UNIT V COMPUTER VISION AND AI FOR AUTONOMOUS DRONES**9 Hrs**

Computer Vision and Multi-View Stereo Vision – 3D Vision System Development— Case study-object detection, classification, Image Annotation, Data Annotation and airborne tracking using OpenCV and Pytorch

Max. 45 hrs**COURSE OUTCOMES:**

On completion of the course, student will be able to

CO1— Apply the mathematical/engineering concepts in building drones

CO2 —Analyze the mathematical relation between force, equilibrium, stability and the movement of drones

CO3 — Select appropriate sensors and actuators for specific application requirements.

CO4 — Develop navigational systems for autonomous drones.

CO5 — Appraise the performance of computer vision in drones

CO6 — Design an autonomous drone for mission control application.

TEXT / REFERENCE BOOKS

1. Syed Omar Faruk Towaha, "Building Smart Drones with ESP8266 and Arduino: Build exciting drones by leveraging the capabilities of Arduino and ESP8266" Packt Publishing, 2018

2. Aaron Asadi, "Drones The Complete Manual. The essential handbook for drone enthusiasts", Imagine Publishing Limited, 2016
3. Neeraj Kumar Singh, PorselvanMuthukrishnan, Satyanarayana Sanpini, "Industrial System Engineering for Drones: A Guide with Best Practices for Designing", Apress, 2019
4. V Kishore Ayyadevara, Yeshwanth Reddy, "Modern Computer Vision with PyTorch", Packt, 2020.
5. K R Krishna, "Agricultural Drones: A Peaceful Pursuit", Apple Academic Press; CRC Press, 2018

END SEMESTER EXAMINATION QUESTION PAPER PATTERN**Max. Marks: 100****Exam Duration: 3 Hrs.****PART A:** 5 Questions of 6 Marks each – No choice**30 Marks****PART B:** 2 Questions from each unit of internal choice, each carrying 14 Marks**70 Marks**