ET3201	REAL TIME OPERATING SYSTEM	LT P C 2 0 2 3

UNIT I REVIEW OF OPERATING SYSTEMS **6**

Basic Principles - Operating System structures - System Calls - Files - Processes - Design and Implementation of processes - Communication between processes - Introduction to Distributed operating system - Embedded operating systems

UNIT II OVERVIEW OF RTOS **6**

RTOS Task and Task state - Multithreaded Preemptive scheduler - Process Synchronization - Message queues - Mail boxes - pipes - Critical section - Semaphores - Classical synchronization problem - Deadlocks

UNIT III REALTIME MODELS AND LANGUAGES **6**

Event Based - Process Based and Graph based Models - Real Time Languages - RTOS Tasks - RT scheduling - Interrupt processing - Synchronization - Control Blocks - Memory Requirements.

UNIT IV REALTIME KERNEL **6**

Principles - Design issues - Polled Loop Systems - RTOS Porting to a Target - Compar ison and Basic study of various RTOS like - VX works - Linux supportive RTOS - C Executive.

UNIT V APPLICATION DEVELOPMENT **6**

Discussions on Basics of Linux supportive RTOS - uCOS - C Executive for development of RTOS Application - Case study

30 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Hands on laboratory practice/Mini Project/Seminar/etc)

30 PERIODS

LAB EXPERIMENTS

1. Develop a firmware code using a RTOS kernel on a SOC to implement a simple task to blink a led.
2. Using the RTOS kernel explore tasks and inter-task communication methods on a SOC
3. Experiment Task scheduling and task priorities with RTOS kernel.
4. Demonstrate the difference between mutex and semaphores with a RTOS kernel on SOC chip.
5. Using the RTOS kernel implement a multicore programming in which one reads temperature and another core displays value using terminal.
   (Recommended: Free rtos kernel, RP2040 SOC chip)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Outline Operating System structures and types.
CO2: Insight into scheduling, disciplining of various processes execution.
CO3: Illustrate knowledge on various RTOS support modelling
CO4: Demonstrate commercial RTOS Suite features to work on real time processes design.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in RTOS and embedded automation design.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES:

1. Silberschatz, Galvin, Gagne “Operating System Concepts”, 6th ed,John Wiley,2003
2. Charles Crowley, “Operating Systems - A Design Oriented approach” McGraw Hill,1997
3. Raj Kamal, “Embedded Systems- Architecture, Programming and Design” Tata McGraw Hill,2006.
4. Karim Yaghmour, “Building Embedded Linux System”,O’reilly Pub,2003
5. Mukesh Sighal and N G Shi, “Advanced Concepts in Operating System”, McGraw Hill,2000

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	-	2	-
CO2	-	-	2	-	3	1
CO3	2	-	2	1	2	2
CO4	2	2	3	2	1	3
CO5	-	-	1	-	3	1
Average	2	2	1.8	1.5	2.2	1.75

ET3202	EMBEDDED SYSTEM NETWORKING	LT P C 3 0 0 3

UNIT I EMBEDDED PROCESS COMMUNICATION WITH INSTRUMENT BUS 9

Embedded networking: Introduction - Cluster of instruments in System: Introduction to bus protocols - comparison of bus protocols - RS 232C, RS 422, RS 485 and USB standards - ARINC 429- embedded ethernet - MOD bus, LIN bus and CAN bus.

UNIT II EMBEDDED ETHERNET 9

Elements of a network - Inside Ethernet - Building a Network: Hardware options - Cables, Connections and network speed - Ethernet controllers - Inside the internet protocol - Exchanging messages using UDP and TCP - Email for Embedded systems using FTP - Keeping devices and network secure- IPv6, 6LoWPAN

UNIT III WIRELESS COMMUNICATION AND NETWORK 9

Overview of wireless communication- MIMO-OFDM system- Multiple access techniques in wireless communication- Wireless personal area networks- Ad-hoc wireless networks.

UNIT IV WIRELESS EMBEDDED NETWORKING 9

Wireless sensor networks - Introduction - Node architecture - Network topology - Localization - Time synchronization - Energy efficient MAC protocols - SMAC - Energy efficient and robust routing - Data centric routing –wifi- bluethooth-zigbee-LORA- WSN Applications - Home Control - Building Automation - Industrial Automation- advanced wireless technologies.

UNIT V COMMUNICATION FOR LARGE ELECTRICAL SYSTEM AUTOMATION 9

Data Acquisition, Monitoring, Communication, Event Processing, and Polling Principles, SCADA system principles - outage management - Decision support application - substation automation, extended control feeder automation, Performance measure and response time, SCADA Data Models, need, sources, interface

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1 : Analyze the different bus communication protocols used for embedded networking
CO2 : Explain the basic concepts of embedded networking
CO3 : Understand the wireless communication concepts
CO4 : Apply the embedded networking concepts in wireless networks
CO5 : Build a system automation for different applications

REFERENCES:

1. Mohammad Ilyas and ImadMahgoub, “Handbook of sensor Networks: Compact wireless and wired sensing systems”, CRC Press,2005
2. Peter W Gofton, “Understanding Serial Communication”, Sybes International, 2000
3. Jan Axelson “Embedded Ethernet and Internet Complete”, Penram publications
4. Krzysztof Iniewski, “Smart Grid, Infrastructure& Networking”, TMcGH,2012
5. Control and automation of electrical power distribution systems, James Northcote-Green, Robert Wilson, CRC, Taylor and Francis, 2006

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	-	-	3	1
CO2	-	2	-	-	2	1
CO3	3	2	2	3	2	3
CO4	2	-	3	3	-	2
CO5	3	-	3	3	-	2
Average	**2.25**	**2**	**2.7**	**3**	**2.3**	**1.8**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3251	AUTOMOTIVE EMBEDDED SYSTEMS	LT P C 3 0 0 3

UNIT I ELECTRONIC ENGINE CONTROL SYSTEMS 9

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Automotive microcontrollers - Electronic control Unit - Hardware & software selection and requirements for Automotive applications – open source ECU - RTOS - Concept for Engine management-Standards; Introduction to AUTOSAR and Introduction to Society SAE - Functional safety ISO 26262 - Simulation and modeling of automotive system components.

UNIT II SENSORS AND ACTUATORS FOR AUTOMOTIVES 9

Review of sensors- sensors interface to the ECU, conventional sensors and actuators, Modern sensor and actuators - LIDAR sensor- smart sensors- MEMS/NEMS sensors and actuators for automotive applications.

UNIT III VEHICLE MANAGEMENT SYSTEMS 9

Electronic Engine Control - engine mapping, air/fuel ratio spark timing control strategy, fuel control, electronic ignition - Adaptive cruise control - speed control - anti-locking braking system - electronic suspension - electronic steering, Automatic wiper control - body control system; Vehicle system schematic for interfacing with EMS, ECU. Energy Management system for electric vehicles - Battery management system, power management system-electrically assisted power steering system - Adaptive lighting system - Safety and Collision Avoidance.

UNIT IV ONBOARD DIAGONSTICS AND TELEMATICS 9

On board diagnosis of vehicles - System diagnostic standards and regulation requirements Vehicle communication protocols Bluetooth, CAN, LIN, FLEXRAY, MOST, KWP2000 and recent trends in vehicle communications - Navigation - Connected Cars technology - Tracking - Security for data communication - dashboard display and Virtual Instrumentation, multimedia electronics - Role of IOT in Automotive systems

UNIT V ELECTRIC VEHICLES 9

Electric vehicles – Components - Plug in Electrical vehicle - V2G - Charging station – Aggregators - Fuel cells/Solar powered vehicles - Autonomous vehicles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability in

CO1: Insight into the significance of the role of embedded system for automotive applications.
CO2: Illustrate the need, selection of sensors and actuators and interfacing with ECU
CO3: Develop the Embedded concepts for vehicle management and control systems.
CO4: Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.

REFERENCES:

1. William B. Ribbens, “Understanding Automotive Electronics”, Elseiver,2012
2. Ali Emedi, Mehrdedehsani, John M Miller, “Vehicular Electric power system- land, Sea, Air and Space Vehicles” Marcel Decker, 2004.
3. L.Vlacic, M.Parent, F.Harahima,” Intelligent Vehicle Technologies”, SAE International,2001.
4. Jack Erjavec,JeffArias, “Alternate Fuel Technology-Electric, Hybrid& Fuel Cell Vehicles”, Cengage , 2012.
5. Electronic Engine Control technology - Ronald K Jurgen Chilton’s guide to Fuel Injection - Ford.
6. Automotive Electricals/Electronics System and Components, Tom Denton, 3rd. Edition, 2004.

7. Uwe Kiencke, Lars Nielsen, “Automotive Control Systems: For Engine, Driveline, and Vehicle”, Springer; 1 edition, March 30, 2000.
8. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 4th Edition, 2004.
9. Automotive Hand Book, Robert Bosch, Bently Publishers, 1997.
10. Jurgen, R., Automotive Electronics Hand Book.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	1	1	-	2
CO2	2	3	2	2	2	3
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	2
Average	**2.75**	**2.8**	**2.4**	**2.4**	**2.75**	**2.2**

ET3252	EMBEDDED CONTROL FOR ELECTRIC DRIVES	LT P C 2 0 2 3

UNIT I INTRODUCTION ELECTRICAL DRIVES 6

Electric drive and its classifications, Four-quadrant drive, Dependence of load torque on various factors, Dynamics of motor-load combination-Solid State Controlled Drives-Machine learning and optimization techniques for electrical drives- IoT for Electrical drives applications.

UNIT II EMBEDDED PROCESSOR 6

Embedded Processor architecture - RTOS - Hardware/software co-design Programming and optimization with SoC processors - control algorithms implementation for power converter.

UNIT III INDUCTION MOTOR CONTROL 6

Types - Speed control methods - PWM techniques- VSI fed three - phase induction motor- Fuzzy logic Based speed control for three phase induction motor - FPGA based three phase induction motor control.

UNIT IV BLDC MOTOR CONTROL 6

Overview of BLDC Motor - Speed control methods - PWM techniques - ARM processor based BDLC motor control - ANN for BLDC Motor control and operation.

UNIT V SRM MOTOR CONTROL 6

Overview of SRM Motor - Speed control methods - PWM techniques - FPGA based SRM motor control - DNN for SRM Motor control and operation.

30 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Hands on laboratory practice / Seminar/ Mini Project/etc)

30 PERIODS

1. Laboratory exercise: Use any System level simulator/MATLAB/open-source platform to give hands-on training on simulation study on Electric drives and control.
   a. Simulation of four quadrant operation and speed control of DC motor
   b. Simulation of 3-phasee inverter.
   c. Simulation of Speed control of Induction motor using any suitable software package.
   d. Simulation of Speed control of BLDC motor using any suitable software package.
   e. Simulation of Speed control of SRM using any suitable software package
2. Seminar: IoT-based Control and Monitoring for DC Motor/ any Electric drives.
3. Mini project.: Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Interpret the significance of embedded control of electrical drives
CO2: Deliver insight into various control strategy for electrical drives.
CO3: Developing knowledge on Machine learning and optimization techniques for motor control.
CO4: Develop embedded system solution for real time application such as Electric vehicles and UAVs.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system skills required for motor control strategy.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES:

1. R.Krishnan, “Electric Motor Drives - Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi,2010.
2. Vedam Subramanyam, “Electric Drives - Concepts and Applications”, Tata McGraw- Hill publishing company Ltd., New Delhi, 2002
3. K. Venkataratnam, “Special Electrical Machines”, Universities Press, 2014.
4. Steve Furber, “ARM system on chip architecture”, Addision Wesley,2010.
5. Ron Sass and AnderewG.Schmidt, “Embedded System design with platform FPGAs: Principles and Practices”, Elsevier, 2010.
6. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	2	-	2	-
CO2	1	1	3	-	-	2
CO3	2	-	-	-	3	-
CO4	1	2	3	1	-	-
CO5	-	-	-	-	3	-
Average	**1.25**	**1.5**	**2.7**	**1**	**2.7**	**2**

ET3211 **EMBEDDED SYSTEM LABORATORY - II** **LT P C**
0 0 4 2

Sl.No	EXPERIMENT DETAIL	EQUIPMENT/ SUPPORTS REQUIRED
1.	Programming with GPU processor	Basic Programming, Camera interface and Motor control logics
2	Programming with TPU processor	Basic Programming, simple Machine learning Implementation
3.	Programming with Raspberry Pi Microcontroller Board: Study on incircuit Emulators, cross compilers, debuggers	Raspberry Pi Boards with peripherals; IDE, Board Support Software Tools /Compiler/others, camera interface, Vision and Image processing application
4.	I/O Programming with Arduino, Raspberry Pi Microcontroller Boards I/O Interfacing: Timers/ Interrupts/ Serial port programming/PWM Generation/ Motor Control/ADC/DAC/ LCD/ RTC Interfacing/ Sensor Interfacing/IoT Applications	Arduino, Rasp berry Pi Microcontroller Boards with peripherals; Board Support Software Tools, peripherals with interface
5.	Programming with DSP processors	Processor Boards with Board Support Tools & Interfaces
6	Real Time Operating Systems (RTOS)	Implementation of RTOS with CPU/GPU/TPU/RPLD
7	IoT implementation with Embedded Systems	Node MCU, Gate way, Embedded processors
8	Mini Project	

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Experiment and demonstrate with simulators, in programming processor boards, processor interfacing/ designing digital controllers

CO2: Design & simulate Arithmetic, Logic programs, Filters, Signal analysis with simulators/experiments, in programming processor boards, processor interfacing/ Tools.

CO3: Develop real time solution for embedded applications.

CO4: Program and compile in various tools & software domains.

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors and its programmable interfacing.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	1	1	2	1
CO2	-	1	2	-	-	-
CO3	1	-	3	2	3	-
CO4	2	2	3	3	3	3
CO5	3	2	3	3	3	3
Average	**1.75**	**2**	**2.4**	**2.25**	**2.75**	**2.33**

ET3212 **EMBEDDED PROGRAMMING LABORATORY – II** **LT P C**
0 0 4 2

Sl.No	EXPERIMENT DETAIL	EQUIPMENT/ SUPPORTS REQUIRED
1.	Programming in Freeware software/ Platforms	Programming Compilers &Platforms on freeware
2.	Software & Modelling tools ✓ Study on MEMS Tools ✓ Study on process Controller modeling ✓ PLC/SCADA/PCB ✓ one type CAD Tool	Personal Computers, Software & programming/modelling tools
3.	Programming & Simulation in GUI Simulators /Tools/others ✓ Graphical User interface simulations & modeling of instrumentation & controllers	Simulation Tools as Labview /others
4.	Programming & Simulation in Python Simulators/Tools/others	Programming in Python Platform/ Open CV, machine learning and Deep learning Implementation
5	Programming with wired/wireless communication protocol/Network Simulators	Learning Communication Protocols & Support Software Tools for BUS & network communication
6	Linux programming Tool chain	PC with Linux OS
7.	Mobile App Development	Open source platforms
7	Automotive and EV Applications studies.	MATLAB/AUTOSAR/ open source
8	Mini project	

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will demonstrate the ability in

CO1: Developing Optimized algorithms for embedded processor on IDE and compilers.
CO2: Outline the concepts of how process can be realized using Software Modules.
CO3: Compare and analyze device, Circuit and System level simulators/emulators to develop embedded applications.
CO4: Incorporate I/O software interface using IDE and High-level languages with processor.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on Embedded programming concepts.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	2	1
CO2	-	3	2	2	-	-
CO3	2	3	3	2	3	2
CO4	-	1	3	3	3	3
CO5	-	-	3	3	3	3
Average	**2**	**2.25**	**2.4**	**2.2**	**2.75**	**2.25**

ET3311 **PROJECT WORK I** **L T P C**
0 0 12 6

COURSE OUTCOMES:
At the end of this course, the students will have the ability in

CO1: Design, Development capability in Building Automation for a process through Hardware & Software Tools.
CO2: Interpreting Pre-Requisites insists choice of project title from the embedded domain of research topics for Project work:
CO3: Demonstrate project work to enhance students' capacity to work in Research Areas of the Department interests or of Industrial importance.
CO4: Demonstrate the skill in Oral and Written Communication as presented in the Thesis Book via Viva-Voce Examination
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation with getting skilled up through learning & practicing in Design / development through simulation / experimental analysis with project report submission (relevant to the candidates project area) by individuals.

TOTAL: 180 PERIODS

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	-	-	-	-	-
CO3	3	-	-	-	-	3
CO4	3	3	3	3	3	3
CO5	2	3	3	3	3	3
Average	**2.8**	**3**	**3**	**3**	**3**	**3**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3411	PROJECT WORK II	L T P C 0 0 24 12

COURSE OUTCOMES:

At the end of this course, the students will have the ability in

CO1: Design, Development capability in Building Automation for a process through Hardware & Software Tools.

CO2: Interpreting Pre-Requisites insists choice of project title from the embedded domain of research topics for Project work:

CO3: Demonstrate project work to enhance students' capacity to work in Research Areas of the Department interests or of Industrial importance.

CO4: Demonstrate the skill in Oral and Written Communication as presented in the Thesis Book via Viva-Voce Examination

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation with getting skilled up through learning & practicing in Design / development through simulation / experimental analysis with project report submission (relevant to the candidates project area) by individuals.

TOTAL: 360 PERIODS

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	-	-	-	-	-
CO3	3	-	-	-	-	3
CO4	3	3	3	3	3	3
CO5	2	3	3	3	3	3
Average	**2.8**	**3**	**3**	**3**	**3**	**3**

ET3061	MACHINE LEARNING AND DEEP LEARNING	LT P C 3 0 0 3

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING - FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1 - Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, rain forest algorithm-multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, case study based on CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1: Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, Yoshua Bengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition, 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer, 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	1	-	-	-
CO2	2	3	2	-	-	-
CO3	3	-	3	-	3	-
CO4	2	3	3	-	-	-
CO5	3	3	3	-	3	-
Average	**2.2**	**3**	**2.4**	**-**	**3**	