SOMAIYA VIDYAVIHAR UNIVERSITY

K J Somaiya College of Engineering

Syllabus Open Technical Electives

T.Y. B.Tech

Offered by

Department of Electronics and Electronics and Telecommunication Engineering

Semester V and VI

From
Academic Year 2022 – 23
(Revision 1)

(Approved by FOET dated xxxxxxx and AC dated xxxx)

K J Somaiya College of Engineering, Mumbai-77

(A Constituent College of Somaiya Vidyavihar University)

Semester V

Open Electives (Technical) – 2 credits (3-0-0)			
Course Code	**Course Title**	**Course Code**	**Course Title**
116U06O531	Deep learning and Fuzzy Logic	116U06O532	R Programming for data analysis
116U06O533	Data Networking and Practices	116U06O534	Consumer Electronics

Semester VI

Open Electives (Technical)- 2 credits (3-0-0)			
Course Code	**Course Title**	**Course Code**	**Course Title**
116U06O631	Switching and Routing	116U06O632	Advanced Deep Learning and Deployment
116U06O633	Time Series analytics and Forecasting	116U06O634	Microcontroller System Design using ARM

Course Code	Course Title						
116U06O531	Deep Learning and Fuzzy Logic						
	TH			P		TUT	Total
Teaching Scheme (Hrs.)	3			-		-	3
Credits Assigned	2			-		-	2
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	30	20	-	--	--	–	50

Course prerequisites: Calculus, Linear Algebra, Probability & Statistics

Course Objectives

- Understand how human solve basic classification, recognition and sequential problem.
- Study selected topics of Deep Learning, discussing recent models from both supervised and unsupervised learning.
- Use of deep learning to solve different real world problems.
- Mimicking remarkable ability of the human mind to reason and learn in an environment of uncertainty and imprecision.

Course Outcomes

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

CO1. Understand the fundamentals of deep learning.
CO2. Apply the fundamental principles of mathematics for learning deep neural networks
CO3. Understand concepts, issues and practices when training deep neural network
CO4. Understand deep learning algorithms and models
CO5. Implement deep learning algorithms and solve real-world problems.
CO6. Understand the concept of Fuzzy logic, fuzzy rules and fuzzy reasoning.

Module No.	Unit No.	Details	Hrs	CO
1	**Introduction to Neural Networks and its Basic Concepts:**			
	1.1	Neuroscience inspiration, perceptron, cost functions, hypotheses, training data, activation functions, feed-forward networks, MLP, review of fundamental learning techniques.	6	**CO 1**
	1.2	Learning via gradient descent, backpropagation, output units: linear, softmax; hidden units: tanh, RELU		
	1.3	Reasons to go Deep		
2	**Neural Networks Learning and Algorithms**			
	2.1	Forward and Backpropagation algorithms, Gradient Descent (GD), Momentum Based GD, Nesterov's Accelerated GD, AdaDelta, AdaGrad, Adam	9	**CO2, CO3**
	2.2	Regularization: Bias variance tradeoff, L2 regularization, Early stopping, Batchnorm, Dataset augmentation, Dropout		
3	**Deep learning algorithms and model for image and language**			
	3.1	Convolutional Neural Networks(CNN), AlexNet, VGGNet, GoogLeNet, ResNet, transfer learning	13	**CO4, CO5**
	3.2	Region-CNN (R-CNN), Fast R-CNN, Faster R-CNN, You Only Look Once (YOLO)		
	3.3	Sequence learning problems, recurrent neural networks, backpropagation through time, vanishing and exploding Gradients, word embedding		
4	**Recent trends in Deep learning**			
	4.1	Gated Recurrent Units (GRUs), Long Short Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs	9	**CO4, CO5**
	4.2	Encoder Decoder Models, Attention Mechanism, Attention over images, Generative Adversarial Networks (GANs)		
5	**Fuzzy logic**			
	5.1	Fuzzy sets, properties, operations, fuzzy relation, extension principle, membership function, fuzzy rules, defuzzification	8	**CO6**
	5.2	Fuzzy inference systems, Mamdani Fuzzy models, and Fuzzy knowledge based controllers		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Jacek M. Zurada	*Introduction to Artificial Neural Systems*	Jaico Publishing House, India	1992
2.	Ian Goodfellow, Yoshua Bengio, Aaron Courville	*Deep Learning*	MIT Press	3 January 2017
3.	Geron Aurelien	*Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*	O'Reilly	4th edition, 2017
4.	Francois Chollet	*Deep Learning with Python*	Manning Publications	1st edition, 2017
5.	Thimothy J. Ross	*Fuzzy Logic with Engineering Applications*	Wiley, India	Third edition, 2011

Course Code	Course Title						
116U06O532	R Programming for Data Analysis						
	TH			P		TUT	Total
Teaching Scheme (Hrs.)	3			-		-	3
Credits Assigned	2			-		-	2
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	30	20	-	--	--	–	50

Course prerequisites: None

Course Objectives:
R is a statistical programming language and environment. It is a free and open source software and hence is easily available. The goal of this course is to introduce students to the R programming environment and related eco-system and thus provide them with an in-demand skill-set, in both the research and business environments.

Course Outcomes
At the end of successful completion of the course the student will be able to
CO1. Understand the data-types and operators in R
CO2. Import data from the various sources of files and visualize the data using graphs
CO3. Implement statistical concepts and make decisions using hypothesis testing
CO4. Apply machine learning algorithms for regression and classification
CO5. Identify the trends and patterns in the data and apply concepts of data analysis in the datasets

Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to R Programming		5	CO1
	1.1	Installation of R and RStudio		
	1.2	R-Data types- Vectors, Lists , Matrices, Arrays , Factors, Data Frames		
	1.3	Operators in R- Arithmetic Operators, Relational Operators , Logical Operators , Assignment Operators		
2	Data Analysis		10	CO2
	2.1	Data Import Techniques – Importing data from spreadsheets, text files, Web Data, Database		
	2.2	Data Visualization Techniques- Histogram, Frequency Polygon, Box plot, Scatter plot, Pie chart, Bar plot, Stem and Leaf Plot, Ogive		
	2.3	Decision Making Techniques – if statements, if – else statements, switch statements, for loop and while loop statement		
3	Data Exploration		14	CO3
	3.1	Basic Steps of Data Exploration		
	3.2	Statistical Parameters : Mean , Mode, Median, Variance, Standard Deviation, Co-relation Co-efficient		
	3.3	Parameter Estimation – Point estimation and Interval Estimation		
	3.4	Analyzing distribution of Data – Central limit Theorem		
	3.5	Hypothesis Testing – p test, t test		
4	Data Mining Techniques		10	CO4
	4.1	Statistical Model using Linear regression		
	4.2	Statistical Model using Multiple Linear Regression		
	4.3	Logistic Regression		
	4.4	Clustering Techniques		
5	Case- Study		6	CO5
	5.1	Car Price Prediction		
	5.2	Credit Card Fraud Detection		
	5.3	Customer Segmentation		
		Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Tony Fischetti	*Data Analysis with R*	Packt Publishing Limited, UK	First Edition, 2015
2.	Seema Acharya	*Data analytics using R*	McGraw Hill Education Private Limited, chennai	First Edition, 2018
3.	Brett Lantz	*Machine Learning with R*	PACKT publishing, UK	Second Edition, July 2015

Course Code	Course Title						
116U06O533	Data Networking and Practices						
	TH		P			TUT	Total
Teaching Scheme (Hrs.)	3		-			-	3
Credits Assigned	2		-			-	2
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	30	20	-	--	--	–	50

Course prerequisites: Basic Communication system concepts

Course Objectives:

This course is on the organization and management of local area networks (LANs). The course objectives include learning about computer network organization and implementation, obtaining a theoretical understanding of data communication and computer networks, and gaining practical experience in installation, monitoring, and troubleshooting of LAN systems. The course introduces data network design and its operations. On completion of the course, the student should be able in part to design, implement and maintain a typical computer network (LAN).

Course Outcomes

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

CO1: Explain key networking protocols, and their hierarchical relationship in the context of a conceptual model
CO2: Describe the hardware and software that comprise an enterprise network and articulate component integration for network solution.
CO3: Understand IPv4 addressing systems and subnetting.
CO4: Understand the transport layer protocols and subsequent communications that allow networked hosts and applications to communicate across the internet.
CO5: Design network architectures for given requirements and constraints with multiple host configuration.

Module No.	Unit No.	Details	Hrs.	CO
1	**Physical layer and Data Link**		07	CO 1
	1.1	Network protocols and standards: Protocol Suites, Standard Organizations, Reference Models Data Transfer in the Network: Data Encapsulation, Data Access		
	1.2	Physical layer Protocols: Physical Layer Connection, Purpose of the Physical Layer, Physical Layer Characteristics		
	1.3	Network Media: Copper Cabling, UTP Cabling, Fiber-Optic Cabling, Wireless Mediar		
	1.4	Data link layer Protocols: Purpose of the Data Link Layer, Data Link Sublayers, Data Link Layer Standards		
2	**Explore and Configure Network Devices**		07	CO1
	2.1	LANs,WANs, Internet, The Internet, Intranets, and Extranets, Internet Connections, Converged Networks, Reliable Network Network Environment		
	2.2	IOS Bootcamp: IOS Access, Navigate the IOS, The Command Structure, Basic device configuration: Hostnames, Limit Access to Device Configurations, Save Configurations		
	2.3	Address schemes: Ports and Addresses, Configure IP Addressing, Verifying Connectivity		
3	**Network Access and Network Protocol**		09	CO 2
	3.1	Media Access Control: Topologies, WAN Topologies, LAN Topologies, Data Link Frame		
	3.2	Ethernet Protocol : Ethernet Frame, Ethernet MAC Addresses LAN Switches: The MAC Address Table, Switch Forwarding Methods, Switch Port Settings		
	3.3	Address Resolution Protocol: MAC and IP, ARP, ARP Issues		
	3.4	Routers and Routing: Anatomy of a Router, Router Boot-up, Configure a Router, How a Host Routes, Router Routing Tables		
4	**IP Addressing**		07	CO 3
	4.1	IPv4 Network addresses: Binary and Decimal Conversion, IPv4 Address Structure, 3 IPv4 Unicast, Broadcast, and Multicast, Types of IPv4 Addresses		
	4.2	Subnetting a Ipv4 Connectivity Verification		

5	**Transport Layer**		**09**	**CO4**
	5.1	Transport Layer Protocol: Transportation of Data		
	5.2	TCP: TCP Communication Process, Reliability and Flow Control		
	5.3	UDP: UDP Communication		
	5.4	Application using TCP and UDP		
6	**Application Layer**		**06**	**CO5**
	6.1	Application Layer Protocol: HTTP, Email , SMTP, POP, DNS, DHCP, FTP		
	6.2	Network Design: Devices in a Small Network, Small Network Applications and Protocols, Scale to Larger Networks		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	J. F. Kurose and K. W. Ross	*Computer Networking: A Top-Down Approach*	Pearson Publication, India	5th Edition, 2012
2.	B. Forouzan,	*Data Communication and Networking*	McGraw Hill Publication, India	5th Edition. 2013
3.	L. Garcia et al	*Communication Networks*	McGraw Hill Publication, India	2nd Edition, 2004

Course Code	Course Title						
116U06O534	Consumer Electronics						
	TH			P		TUT	Total
Teaching Scheme (Hrs.)	3			-		-	3
Credits Assigned	2			-		-	2
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	30	20	-	--	--	–	50

Course prerequisites:

- Elements of Electrical and Electronics Engineering

Course Objectives

Basic knowledge for various electronics audio-video systems and home appliances is necessary for engineering students of any discipline. This multidisciplinary course will introduce the students with working principles, block diagram, advance features and basic troubleshooting of consumer electronics appliances like audio-video systems, microwave oven, washing machine, air-conditioner, etc. which in-turn will develop understanding towards diagnosis fault and rectification of that in a systematic way. The objective of the course is also to create awareness about product safety and compliance standards of consumer electronic products.

Course Outcomes

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

CO1. Understand various phases of product development
CO2. Illustrate working principle of audio systems
CO3. Describe operating principle of video and display systems
CO4. Illustrate functions and basic troubleshooting of several domestic appliances
CO5. Evaluate and analyze product safety and compliance standards

Module No.	Unit No.	Details	Hrs.	CO
1	**Electronic Product Design**		10	CO 1
	1.1	Electronic Products Classification- Consumer, Industrial and Military, characteristics in terms of cost/performance ratio and reliability		
	1.2	Reliability- Bath tub curve, Measures taken (at component and product level and various soldering techniques including Surface Mount Technology) to improve reliability		
	1.3	Elements of successful design- cognition, ergonomics packaging and factors, planning, design for manufacture, assembly and disassembly, testing		
2	**Audio Systems**		06	CO 2
	2.1	Basic concepts of microphone, loudspeaker, mono, stereo, equalizers, mixer synthesizers		
	2.2	Audio recording and storage devices		
	2.3	Technical specifications, Block diagram, working principle, applications, troubleshooting of- Audio Compact disc system, Home theater system, Public address system		
3	**Video Systems**		10	CO 3
	3.1	Monochrome, Color TV standards, Interlaced and Progressive scanning, Composite video signal, Component digital video		
	3.2	Digital TV (DTH with set-top box)		
	3.3	HDTV-standards, compatibility		
	3.4	Displays- Plasma, LCD, LED, OLED		
		#Self-learning topics: Color TV System (PAL)		
4	**Domestic and Consumer Appliances**		10	CO 4
	4.1	Technical specifications, Block diagram, working principle, applications, troubleshooting of- 1. Microwave Ovens 2. Air Conditioner 3. Refrigerator 4. Washing Machine 5. Cellular Mobile Systems		
5	**Product compliance standards**		09	CO 5
	5.1	Product safety and liability issues		
	5.2	Standards related to electrical safety and fire hazards		
	5.3	EMI/EMC standards		
	5.4	RF interference and immunity		
		Total	45	

 # Learners should prepare all self-learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA.

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	S. P. Bali	*Consumer Electronics*	Pearson Education	2nd Edition, 2007
2.	B. R. Gupta, V. Singhal	*Consumer Electronics*	S.K. Kataria & Sons	5th Edition, 2014
3.	R. R. Gulati	*Monochrome and Color Television*	New Age International Publisher	3rd Edition, 2014
4.	R. G. Kaduskar	*Electronic Product Design*	Wiley	2nd Edition, 2011

Course Code	Course Title						
116U06O631	Switching and Routing						
	TH			P		TUT	Total
Teaching Scheme (Hrs.)	3			-		-	3
Credits Assigned	2			-		-	2
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	30	20	-	--	--	–	50

Course Prerequisites: Basics of computer networks

Course Objectives

The course introduces the basic configuration of a switch and a router and their implementation in Local Area Network and Virtual Local Area Network. It helps to understand various routing algorithms and protocols and their implementation in network. It helps to correlate the home network Dynamic Host Configuration Protocol and Network Address Translation configuration with the theory and practical implementation.

Course Outcomes

At the end of successful completion of the course the student will be able to
CO 1. Design Campus Network using Local Area Network
CO 2 Understand and implement Virtual Local Area Network and switch security
CO 3 Implement various routing algorithms and protocols
CO 4. Analyze and configure Dynamic Host Configuration Protocol
CO 5. Understand Network Address Translation used with IPv4 addressing.

Module No.	Unit No.	Details	Hrs.	CO
1	**Switching Concepts and Switch Configuration**		07	CO1
	1.1	Introduction to Switched Networks: Converged networks, Switched Networks, Frame Forwarding, switching domains		
	1.2	Basic Switching Concepts and Configuration: Configure a switch with Initial Settings, Configure Switch ports		
	1.3	Switch Security: Secure Remote Access, Security Concerns in LAN, switch port security		
2	**Virtual Local Area Networks**		07	CO2
	2.1	VLAN segmentation, Overview of VLANs, LANs in a Multi-Switched Environment,		
	2.2	VLAN implementation: VLAN Assignment, VLAN Trunks, Dynamic Trunking Protocol,		
	2.3	VLAN Security and Design: Attacks on VLANs, Design Best Practices for VLANs		
3	**Routing Concepts**		10	CO3
	3.1	Initial configuration of Router: Characteristics of a network, functions of a router, connect to a network, Basic Settings on a Router, Verify Connectivity of Directly Connected Networks,IPv6		
	3.2	Routing Decision: Switching Packets Between Networks, Path Determination		
	3.3	Router Operation: Analyze the Routing Table, Directly Connected Routes, Statically Learned Routes		
	3.4	Inter-VLAN Routing: Inter-VLAN Routing Operation, Configure Legacy Inter-VLAN Routing, Configure Router-on-a-Stick Inter-VLAN Routing, Troubleshoot Inter-VLAN Routing, Inter-VLAN Configuration Issues, IP Addressing Issues		
4	**Static and Dynamic Routing Protocols**		10	CO3
	4.1	Static Routing Implementation: Static Routing, Types of Static Routes		
	4.2	Configure Static and Dynamic Routes: Configure IPv4 Static Routes, Configure IPv4 Default Routes, Configure IPv6 Static Routes, Configure IPv6 Default Routes, Classful Addressing, CIDR,VLSM		
	4.3	Dynamic Routing Protocol operation, Dynamic versus static Routing, Routing Protocol Operating Fundamentals, Types of Routing Protocols, Distance Vector Dynamic Routing, Configuring the RIP Protocol, Configuring the RIPng Protocol, Link-State Dynamic Routing		
	4.4	Routing Table: Routing Table Entries, Dynamically Learned IPv4 Routes, The IPv4 Route Lookup Process		

Module No.	Unit No.	Details	Hrs.	CO
5	**Dynamic Host Configuration Protocol**		**06**	**CO4**
	5.1	Introduction: DHCPv4 Operation, Configuring a Basic DHCPv4 Server, Configure DHCPv4 Client		
	5.2	DHCP version 6: SLAAC and DHCPv6, Stateless DHCPv6, Stateful DHCPv6 Server		
6	**Network Address Translation for IPv4**		**05**	**CO5**
	6.1	NAT Operation, NAT Characteristics, Configuring static and dynamic NAT, Configuring Port Address Translation (PAT)		
	6.2	Access Control Lists (ACL) : Purpose of ACLs, Standard IPv4 ACLs, Extended IPv4 ACLs		
		Total	**45**	

Recommended Online Resources:

www.cisconetacad.com

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	B. Forouzan,	*Data Communication and Networking*	McGraw Hill Publication, India	5th Edition. 2013.
2.	L. Garcia et al	*Communication Networks*	McGraw Hill Publication, India	2nd Edition,2004.

Course Code	Course Title						
116U06O632	Advanced Deep Learning and Deployment						
	TH		P		TUT	Total	
Teaching Scheme (Hrs.)	3		-		-	3	
Credits Assigned	2		-		-	2	
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	30	20	-	--	--	–	50

Course prerequisites: Calculus, Linear Algebra, Probability & Statistics, python programming

Course Objectives

There have been many recent advances in the field of deep learning. The objective of the course is to provide exposure to these advances and facilitate in depth discussions on chosen topics. The course is also provides exposure to deployment of deep learning model.

Course Outcomes

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

CO1. Learn and implement computer vision task using deep learning
CO2. Understand attention mechanisms
CO3. Learn Transformers and pre-training
CO4. Implement deep learning algorithms to solve natural language processing problems.
CO5. Deploy deep learning models

Module No.	Unit No.	Details	Hrs	CO
1	**Deep Learning for Computer Vision**		12	**CO1**
	1.1	Introduction to image classification using CNN, fine tuning, VGGNet, GoogLeNet, ResNet, DenseNet		
	1.2	Object Detection: Bounding Boxes, Anchor Boxes, Multiscale Object Detection, The Object Detection Dataset, Single Shot Multibox Detection, Region-based CNNs, Semantic Segmentation and the Dataset,		
	1.3	Neural Style Transfer: Image preprocessing, building loss functions, constructing a custom optimizer, style transfer in action		
2	**Attention Mechanisms**		10	**CO2**
	2.1	Attention Cues, Attention Pooling: Nadaraya-Watson Kernel Regression, Attention Scoring Functions, Bahdanau Attention, Multi-Head Attention		
	2.2	Self-Attention and Positional Encoding, Transformers		
3	**Natural Language Processing: Pretraining**		8	**CO3**
	3.1	Word Embedding (word2vec), Approximate Training, The Dataset for Pretraining Word Embedding, Pretraining word2vec, Word Embedding with Global Vectors (GloVe), Subword Embedding, Word Similarity and Analogy		
	3.2	Bidirectional Encoder Representations from Transformers (BERT), The Dataset for Pretraining BERT, Pretraining BERT		
4	**Natural Language Processing: Applications**		10	**CO4**
	4.1	Sentiment Analysis Dataset, Sentiment Analysis: Using RNN and CNN		
	4.2	Natural Language Inference and the Dataset, Natural Language Inference: Using Attention		
	4.3	Fine-Tuning BERT for Sequence-Level and Token-Level Applications, Natural Language Inference: Fine-Tuning BERT		
5	**Deep Learning Model Deployment**		5	**CO5**
	5.1	Device-based Models with TensorFlow Lite		
	5.2	Introduction to tools to deploy deep learning models and use one tool to deploy deep learning model		
		Total	**45**	

Recommended Books :

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola	*Dive into Deep Learning*	https://d2l.ai/	Release 0.17.0, July 25, 2021
2.	Ian Goodfellow, Yoshua Bengio, Aaron Courville	*Deep Learning*	MIT Press	3 January 2017
3.	Geron Aurelien	*Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*	O'Reilly	4th edition, 2017
4.	Francois Chollet	*Deep Learning with Python*	Manning Publications	1st edition, 2017
5.	Sunil Patel	*Getting started with Deep Learning for Natural Language Processing: Learn how to build NLP applications with Deep Learning*	BPB Publications	1st edition, 2021

Course Code	Course Title						
116U06O633	Time Series analytics and Forecasting						
	TH			P		TUT	Total
Teaching Scheme (Hrs.)	3			-		-	3
Credits Assigned	2			-		-	2
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	30	20	-	--	--	–	50

Course prerequisites: Basics of Probability theory and Statistics

Course Objectives

Time Series consist of values of a variable recorded in an order over a period of time. Such data arise in fields of engineering, econometrics and finance, medicine, genetics, sociology, environmental science. What makes time series data special is the presence of dependence between observations in a series, and the fact that usually only one observation is made at any given point in time. This means that standard statistical methods are not appropriate, and special methods for statistical analysis are needed. This course introduces the concepts and methods of time-series analysis in time domain.Topics covered are: descriptive methods, plots, smoothing, differencing; the autocorrelation function, the correlogram; estimation and elimination of trend and seasonal components; stationary processes, modeling and forecasting with autoregressive moving average (ARMA) models; non-stationary and seasonal time series models; ARIMA and SARIMA processes, identification, estimation and diagnostic checking, forecasting, exponential smoothing, and the Box-Jenkins approach.

The course includes use of software(Python\R) to provide hands on experience of fitting time series models to real life datasets, of carrying out diagnostics tests to test model quality and forecasting.

Course Outcomes

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

CO1. Learn and use mathematical considerations for analyzing time series, including concepts of stochastic processes, stationarity and statistical tools for evaluation of time series models
CO2. Define and explain time series components trend, seasonality and use difference and lag operators
CO3. Construct, explain and interpret MA AR and ARMA models
CO4. :Construct, explain and interpret ARIMA and SARIMA models
CO5. Use simulation software to build the models from real life time series data, and draw conclusions and develop solutions from the estimated mode

Module No.	Unit No.	Details	Hrs.	CO
1	**Basic Preliminaries**		11	CO1
	1.1	Definition of time series , plotting time series data, examples of time series data, univariate and multivariate time series, challenges in time series analysis		
	1.2	Hypothesis testing; Simple linear regression model, measuring linear association with correlation function, Diagnostics of linear regression model, Regression performance evaluation metrics- MAE, MASE, RMSE, MAPE; Statistical tools to evaluate quality of fitted time series model-SSE, AIC, BIC, Ljung-Box statistical Test; importance of residuals in time series analysis;		
	1.3	Continuous and discrete Stochastic processes, ensembles and realizations, mean, variance and autocovariance function, stationarity properties		
2	**Introduction to Tine series analysis**		8	CO2
	2.1	Time series as a realization of a stochastic process, producing meaningful time series plots for various datasets, auto-covariance function of a time series data, Estimation of auto-covariance coefficients of a time series at different lags, stationary time series, autocorrelation function, Estimation of autocorrelation coefficients of a time series at different lags, correlograms		
	2.2	Random walk model, correlogram of a random walk, trend removal using difference operator		
3	**Stationary time series processes**		12	CO3
	3.1	Moving Average(MA) process, identification of MA process, Interpretation of correlogram of a MA process, stationarity of White noise, random walk and MA process, use of backward shift operator to write MA(q) process, Invertibility condition to guarantee unique MA process corresponding to observed ACF, Necessary and sufficient condition for invertibility of MA process, fit MA(q) model to real life datasets and estimate model parameters		
	3.2	Autoregressive(AR) processes, Stationarity condition for AR(p) processes, Backshift operator and ACF, ACF of AR processes using Yule – Walker equations, PACF to estimate the order of AR(p) processes, Duality of MA and AR processes, fit AR(p) model to real life datasets and estimate model parameters		
	3.3	ARMA(p,q) processes, fit ARMA(p,q) model to real life datasets and estimate model parameters		
4	**Non-Stationary time series process-ARIMA Processes**		8	CO4
	4.1	Non-stationarity of real life data; ARIMA processes, Identification techniques, writing ARIMA models using backshift and difference operators		

	4.2	Fitting ARIMA models to real world datasets and selection of a better model using statistical tools like ACF, PACF, AIC; Application of Ljung-Box test for testing correlation in a time series; Forecasting using fitted ARIMA model		
5	**Non-Stationary time series process-SARIMA Processes**		**6**	**CO5**
	5.1	SARIMA Processes, Box-Jenkins SARIMA model, checking Stationarity and Invertibility of SARIMA process, ACF and PACF of SARIMA model, write SARIMA models using backshift and difference operators		
	5.2	Fit SARIMA models to real world datasets, select the model based on minimum value of AIC, the parsimony principle, Time plot, ACF and PACF of residuals, Ljung-Box test for residuals		
	5.3	Forecasting with SARIMA model- i) using simple exponential smoothing, ii)using double exponential smoothing iii) using triple exponential smoothing		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Box G.E., G. M. Jenkins, G.C. Reinsel and Greta M. Ljung	*Time Series Analysis: Forecasting and Control*	Wiley, U.S.A.	5th Edition, 2015
2.	Robert H. Shumway and David S. Stoffer	*Time Series Analysis and its Applications: With R Examples*	Springer, U.S.A	4th Edition, 2017
3.	Jonathan D. Cryer Kung-Sik Chan	*Time Series Analysis with Applications in R*	Springer, U.S.A	2nd Edition, 2008
4.	Dr. Avishek Pal, Dr. PKS Prakash	*Practical Time Series Analysis*	Packt , U.K.	1ST Edition, 2017

Course Code	Course Title						
116U06O634	Microcontroller System Design using ARM						
	TH		P		TUT	Total	
Teaching Scheme (Hrs.)	3		-		-	3	
Credits Assigned	2		-		-	2	
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	30	20	-	--	--	–	50

Course prerequisites:

- Basics of microcontroller (8051), Basics of C programming

Course Objectives

Microcontrollers are the integral part of any embedded systems. The course will enable students to learn advance programming of ARM Microcontroller and essential fundamentals for interfacing different peripheral devices to develop applications.

Course Outcomes

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

CO1. Understand architecture of ARM Cortex M4
CO2. Develop programs for ARM microcontroller in Embedded C and IDE
CO3. Interface peripherals with ARM microcontroller
CO4. Understand serial communication protocols
CO5. Develop various applications using ARM microcontroller

Module No.	Unit No.	Details	Hrs.	CO
1	**ARM 32-bit Microcontroller(LPC2148)**		**12**	**CO2,CO3,CO4,CO5**
	1.1	Data flow model of ARM		
	1.2	GPIO, ADC, DAC		
	1.3	Timer, RTC		
	1.4	UART		
	1.5	#Application development based on LPC 2148		
2	**Cortex-M4F Processor**		**09**	**CO 1**
	2.1	CPU block diagram, System component details		
	2.2	Programming model, processor mode		
	2.3	Memory model, Register map, power management		
	2.4	Exceptions and Interrupts		
	2.5	Instruction set		
3	**Tiva Launchpad (TM4C123GH6PM)**		**16**	**CO2,CO3,CO4**
	3.1	Introduction to Tiva Launchpad, Development software (CCS, KEIL, Energia), CMSIS		
	3.2	GPIO, Timer		
	3.3	I2C,SPI,UART		
	3.4	PWM, applications of TIVA		
	3.5	#Application development based on TIVA Launchpad		
4	**STM32 Microcontroller**		**08**	**CO2,CO3,CO4,CO5**
	3.1	Introduction to STM32, Development software (STM32Cube)		
	3.2	GPIO, Timers		
	3.3	ADC ,DAC		
	3.4	UART, SPI, I2C: Overview, Key features, Data format, Control Registers		
		Total	**45**	

 # Learners should prepare all self-learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Joseph Yiu	*The Definitive Guide to ARM CORTEX M3 and CORTEX M$*	Newnes	Third Edition 2013
2.	Yifeng Zhu	*Embedded Systems with ARM Cortex-M Microcontrollers in Assembly*	E-Man Press LLC	2nd Edition 2016
3.	Carmine Noviello	*Mastering the STM32 Microcontroller*	Leanpub	2016
4.	Muhammad Ali Mazidi	*STM32 Arm Programming for Embedded Systems: Volume 6*	MicroDigitalEd	2018
5.	Andrew Sloss, Dominic Symes, and Chris Wright	*ARM System Developer's Guide*	Morgan Kaufmann Publishers	1st Edition 2004