SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (AUTONOMOUS)
(Approved by AICTE, New Delhi, Affiliated to JNTUK, Kakinada)
Accredited by NAAC with 'A+' Grade, Accredited by NBA (UG: Civil, CSE, ECE, EEE,IT& ME)
Recognised as Scientific and Industrial Research Organisation
SRKR MARG, CHINA AMIRAM, BHIMAVARAM – 534204 W.G.Dt., A.P., INDIA

Estd:1980

LIST OF OPEN ELECTIVES
OFFERED BY VARIOUS DEPARTMENTS TO OTHER DEPARTMENTS
IN IV YEAR I SEMESTER OE-III

Offered by	Course Code	Course Name	Offered to
ARTIFICIAL INTELLIGENCE & DATA SCIENCE	B20ADOE04	Machine Learning	**CE, ECE, EEE & ME**
CIVIL ENGINEERING	B20CEOE05	Alternative Energy Sources	**AIDS, CSBS, CSE, ECE, & IT**
COMPUTER SCIENCE & BUSINESS SYSTEMS	B20CBOE04	Human Resource Management	**CE, ECE, EEE & ME**
COMPUTER SCIENCE & ENGINEERING	B20CSOE07	Operating Systems	**CE, ECE, EEE & ME**
	B20CSOE08	Machine Learning	
	B20CSOE09	Data Science	
ELECTRONICS & COMMUNICATION ENGINEERING	B20ECOE05	Digital Signal Processing	**AIDS, CE, CSBS, CSE, EEE, IT & ME**
	B20ECOE06	Image Processing	
ELECTRICAL & ELECTRONICS ENGINEERING	B20EEOE02	Matlab programming for Engineering applications	**AIDS, CE, CSBS, CSE, IT & ME**
INFORMATION TECHNOLOGY	B20ITOE05	Cloud Computing	**CE, ECE, EEE & ME**
MECHANICAL ENGINEERING	B20MEOE07	Green Energy Systems	**AIDS, CE, CSBS, CSE, ECE& IT**
	B20MEOE08	Total Quality Management	**AIDS, CE, CSBS, CSE, ECE, EEE & IT**
	B20MEOE09	Supply Chain Management	
MATHEMATICS AND HUMANITIES	B20BSOE03	Mathematical Modeling for data science	**CE, CSBS, CSE, ECE, EEE, IT & ME**

Code	Category	L	T	P	C	I.M	E.M	Exam
B20ADOE04	**OE**	**3**	**-**	**--**	**3**	**30**	**70**	**3 Hrs.**

MACHINE LEARNING

(Offered by AIDS)

(Offered to CE, ECE, EEE & ME)

Course Objectives:

1	Identify problems that are amenable to solution by ANN methods, and which ML methods may be suited to solving a given problem.
2	Formalize a given problem in the language/framework of different ANN methods (e.g., as a search problem, as a constraint satisfaction problem, as a planning problem, as a Markov decision process, etc).

Course Outcomes: After completion of the course, the student will be able to

S.No	Outcome	Knowledge Level
1	Explain the fundamental usage of the concept Machine Learning system	K3
2	Demonstrate on various regression Technique	K3
3	Analyze the Ensemble Learning Methods	K3
4	Illustrate the Clustering Techniques and Dimensionality Reduction Models in Machine Learning.	K3
5	Discuss the Neural Network Models and Fundamentals concepts of Deep Learning	K2

SYLLABUS

UNIT-I (12Hrs)	**Introduction-** Artificial Intelligence, Machine Learning, Deep learning, Types of Machine Learning Systems, Main Challenges of Machine Learning. **Statistical Learning**: Introduction, Supervised and Unsupervised Learning, Training and Test Loss, Tradeoffs in Statistical Learning, Estimating Risk Statistics, Sampling distribution of an estimator, Empirical Risk Minimization.
UNIT-II (10 Hrs)	**Supervised Learning** (Regression/Classification): Basic Methods: Distance based Methods, Nearest Neighbor's, Decision Trees, Naive Bayes, **Linear Models:** Linear Regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, **Binary Classification:** Multiclass/Structured outputs, MNIST, Ranking.
UNIT-III (10 Hrs)	**Ensemble Learning and Random Forests:** Introduction, Voting Classifiers, Bagging and Pasting, Random Forests, Boosting, Stacking. **Support Vector Machine:** Linear SVM Classification, Nonlinear SVM Classification SVM Regression, Naïve Bayes Classifiers.
UNIT-IV	**Unsupervised Learning Techniques:** Clustering, K-Means, Limits of K-Means, Using

(8 Hrs)	Clustering for Image Segmentation, Using Clustering for Preprocessing, Using Clustering for Semi-Supervised Learning, DBSCAN, Gaussian Mixtures. Dimensionality Reduction: The Curse of Dimensionality, Main Approaches for Dimensionality Reduction, PCA, Using Scikit-Learn, Randomized PCA, Kernel PCA.
UNIT-V (10Hrs)	**Neural Networks and Deep Learning:** Introduction to Artificial Neural Networks with Keras, Implementing MLPs with Keras, Installing TensorFlow 2, Loading and Preprocessing Data with TensorFlow.
Text Books:	
1.	Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow, 2nd Edition, O'Reilly Publications, 2019
2.	Data Science and Machine Learning Mathematical and Statistical Methods, Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman,25th November 2020
Reference Books:	
1.	Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, 2012.
e-Resources:	
1.	https://www.geeksforgeeks.org/introduction
2.	https://www.w3schools.com/datascience/
3.	https://github.com/jakevdp/PythonDataScienceHandbook

Code	Category	L	T	P	C	IM	EM	Exam
B20CEOE05	**OE**	**3**	**---**	**---**	**3**	**30**	**70**	**3 hrs.**

ALTERNATIVE ENERGY SOURCES

(Offered by CE)

(Offered to AIDS, CSBS, CSE, ECE, & IT)

Course Objectives:

1	Explain the concepts of Non-renewable and renewable energy systems
2	Outline utilization of renewable energy sources for both domestic and industrial applications
3	Analyze the environmental and cost economics of renewable energy sources in comparison with fossil fuels.

Course Outcomes: After completion of the course, the student will be able to

S. No.	Outcome	Knowledge Level
1	Summarize the need of renewable sources in Global scenario	K2
2	Explain the solar thermal conversion processes	K2
3	Explain the wind energy conversion techniques	K2
4	Explain the biomass energy conversion methodologies	K2
5	Explain the principle of ocean thermal energy conversion system	K2

SYLLABUS

UNIT- I (10 hrs.)	Global and National Energy Scenario: Over view of conventional & renewable energy sources - need & development of renewable energy sources - Future of Energy Use, Energy for sustainable development - Potential of renewable energy sources - renewable electricity and key elements - Global climate change - CO2 reduction potential of renewable energy - concept of Hybrid systems.
UNIT- II (10 hrs.)	Solar Energy: Solar energy system - Solar Radiation – Availability - Measurement and Estimation - Solar Thermal Conversion Devices and Storage - Applications Solar Photovoltaic Conversion, applications of solar energy systems.
UNIT- III (10 hrs.)	Wind Energy: Wind Energy Conversion - Site selection, Types of wind turbines, wind Generation and Control. Nature of the wind, , factors influencing wind, wind data and energy estimation, wind speed monitoring, classification of wind, characteristics, applications of wind turbines, offshore wind energy – Hybrid systems, wind resource assessment, Betz limit, site selection, wind energy conversion devices. Wind mill component design, economics and demand side management, energy wheeling, and energy banking concepts. Safety and environmental aspects, wind energy potential and installation in India.

UNIT- IV (10 hrs.)	Biogas: Calorific value and composition of biogas – Bio energy systems – Biomass conversion processes – Thermo chemical conversion processes – biomass gasification – pyrolysis – liquefaction – anaerobic digestion – Urban waste to energy conversion – bio diesel production – Biomass energy programme in India.
UNIT- V (10 hrs.)	Ocean Energy – Principle of Ocean Thermal Energy Conversion (OTEC) – tidal energy conversion – Scheme of development of tidal energy Hydro power plants- types of turbines – estimation of primary and secondary power Geothermal Energy – Geothermal power plants
Text Books:	
1	Non-Conventional Energy Sources by G.D.Rai
2	Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd., 1986.
Reference Books:	
1	Kishore VVN, Renewable Energy Engineering and Technology, Teri Press, New Delhi, 2012
2	Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K., 1996.

Course Code	Category	L	T	P	C	I.M	E.M.	Exam
B20CBOE04	OE	3	--	--	3	30	70	3 Hrs.

HUMAN RESOURCE MANAGEMENT

(Offered by CSBS)

(Offered to CE, ECE, EEE & ME)

Course Objectives: Students are expected to

1	Understand the importance of human resource management as a field of study and as a central management function.
2	Appraise the elements of the HR function (e.g. – recruitment, selection, training and development, etc.) and be familiar with each element's key concepts & terminology;
3	Apply the performance appraisal methods in assessing the employees;
3	Understand the importance of Human resource development;
4	Assess the global HR polices and conditions.

Course Outcomes: After completion of the course, the student will be able to

S.No	Outcome	Knowledge Level
1	Discuss the HR role in the success of business firm.	K2
2	Identify the right methods of staffing activity for an organization.	K4
3	Assess the employee performance by using appraisal techniques.	K3
4	Interpreting the Human resource development activity of an organization.	K2
5	Predict the international environment for choosing suitable HR policy.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to Human Resource Management:** Introduction to HRM: Meaning and Definition of HRM; Nature and Scope of HRM; Objectives of HRM; Functions of HRM; **Strategic Human Resource Management**-Process, Corporate level strategies, Organizational and Human resource Strategies; Merger and Acquisition strategies.
UNIT-II (10 Hrs)	**Staffing;** **HR Planning**-Job Analysis- Need and Team analysis; **Job Description** - Characteristics, contents and steps; Job Specification- information; Uses of job Analysis; Ergonomics. **Recruitment-** Definition and Objectives of recruitment, Strategic Management and recruitment; Recruitment policies; Sources of recruitment; Factors effecting recruitment; **Selection**- Meaning and definition, essential of selection procedure; **Job Evaluation-** Meaning and definition, objectives, principles, procedure of job Evaluation, problems of job evaluation; Merit rating.

UNIT-III (12 Hrs)	**Performance Management:** **Performance Appraisal** -Meaning, Need and purposes; Methods of performance appraisal, Uses of performance appraisal, Problems of performance appraisal, Recent developments in performance appraisal; **Promotions**- Meaning, types, purposes, bases, benefits and problems; **Transfer**- Meaning, Reasons and Types.
UNIT-IV (12 Hrs)	**Human Resource Development:** **Training-**Meaning, Assessment of Training Needs, Training Methods-On the Job, off-the Job Methods-Training Evaluation, Advantages of training. **Management Development**—objectives, principles and methods of Management Development: on the job and off-the job methods; **Career Development Planning-** meaning, need for, steps, process and actions, Succession planning.
UNIT-V (10Hrs)	**Global Human Resource Management & Ethics in Human Resource Management:** **Global recruitment-**Global selection approach; Cross- cultural training; Compensation; Women in International Business; **Ethics-** Meaning, Ethics in job design; Human Resource Planning; Employee Turnover; Wage and Salary Administration; Training and Development.

Text Books:	
1.	Subba Rao P., Personnel and Human Resource Management- Text and Cases, Himalaya Publications, Mumbai, 2013.
2.	Dessler, G., Fundamentals of Human Resource Management ,4th Edition, Pearson,2017.
Reference Books:	
1.	Aswathappa, K., Human Resource and Personnel Management, Tata McGraw Hill New Delhi, 2013.
2.	Seema Sanghi, Human Resource Management, Macmillan Publishers India Ltd., 2017.
3.	Shashi K.Gupta, Human Resource Management, Kalyani Publishers, 2011.
4.	N.Sambasiva Rao and Dr. Nirmal Kumar, Human Resource Management and Industrial Relations, Himalaya Publishing House, Mumbai.

Code	Category	L	T	P	C	I.M	E.M	Exam
B20CSOE07	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

OPERATING SYSTEMS

(Offered by CSE)

(Offered to CE, ECE, EEE & ME)

Course Objectives:

1.	Introduce to the internal operation of modern operating systems
2.	Define, explain, processes and threads, mutual exclusion, CPU scheduling, deadlock, memory management, and file systems
3.	Understand File Systems in Operating System like UNIX/Linux and Windows
4.	Understand Input Output Management and use of Device Driver and Secondary Storage (Disk) Mechanism
5.	Analyze Security and Protection Mechanism in Operating System

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Describe various generations of Operating System and functions of Operating System	K2
2.	Describe the concept of program, process and thread and analyze various CPU Scheduling Algorithms and compare their performance and Solve Inter Process Communication problems	K4
3.	Compare various Memory Management Schemes especially paging and Segmentation in Operating System and apply various Page Replacement Techniques	K3
4.	Apply the concepts of Deadlocks, Secondary storage structure	K3
5.	Analyze Security and Protection Mechanism in Operating System	K4

SYLLABUS

UNIT-I (10 Hrs)	**Operating Systems Overview**: Operating system functions, Operating system structure, Operating systems operations **System Structures**: Operating System Services, User and Operating-System Interface, systems calls, Types of System Calls, system programs.
UNIT-II (10 Hrs)	**Process Concept**: Process scheduling, Operations on processes, Inter-process communication, Communication in client server systems. **Multithreaded Programming**: Multithreading models, Thread libraries, Threading issues. **Process Scheduling**: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling. **Inter-process Communication**: Race conditions, Critical Regions, Mutual exclusion with busy waiting, Sleep and wakeup, Semaphores, Mutexes, Classical IPC Problems - Dining philosophers problem, Readers and writers problem.

UNIT-III (10 Hrs)	**Memory-Management Strategies**: Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation. **Virtual Memory Management**: Introduction, Demand paging, Copy on-write, Page replacement, Page replacement Algorithms
UNIT-IV (10 Hrs)	**Deadlocks**: Resources, Conditions for resource deadlocks, Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention. **Secondary-Storage Structure**: Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.
UNIT-V (10 Hrs)	**System Protection**: Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights. **System Security:** Introduction, Program threats, System and network threats.
Text Books:	
1.	Silberschatz A, Galvin P B, and Gagne G, Operating System Concepts, 9th edition, Wiley, 2013.
2.	Tanenbaum A S, Modern Operating Systems, 3rd edition, Pearson Education, 2008. (for Interprocess Communication and File systems.)
Reference Books:	
1.	Dhamdhere D M, Operating Systems A Concept Based Approach, 3rd edition, Tata McGraw-Hill, 2012.
2.	Stallings W, Operating Systems -Internals and Design Principles, 6th edition, Pearson Education, 2009
3.	Nutt G, Operating Systems, 3rd edition, Pearson Education, 2004
e-Resources:	
1.	https://nptel.ac.in/courses/106/105/106105214/

Code	Category	L	T	P	C	I.M	E.M	Exam
B20CSOE08	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

MACHINE LEARNING

(Offered by CSE)

(Offered to CE, ECE, EEE & ME)

Course Objectives:

1.	To introduce the basic concepts and techniques of Machine Learning
2.	To demonstrate regression, classification and clustering methods.
3.	To introduce the concepts of dimensionality reduction, artificial neural networks and reinforcement learning
4.	To show the application of machine learning model evaluation and optimization techniques

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Formulate the concepts of ingredients and preliminaries of machine learning	K2
2.	Apply tree models, linear models and distance-based models	K3
3.	Identify and construct features and ensemble models	K3
4.	Demonstrate the concepts of dimensionality reduction techniques, model evaluation and selection techniques	K2
5.	Apply the concepts of artificial neural networks, reinforcement learning	K3

SYLLABUS

UNIT-I (12 Hrs)	**The ingredients of machine learning**: Basic concepts, Types of machine learning, **Tasks**: the problems that can be solved with machine learning, **Models**: the output of machine learning, Features. **Preliminaries:** The curse of dimensionality, Overfitting, Training, Test and Validation sets, The confusion matrix, **The accuracy metrics**: Accuracy, sensitivity, specificity, precision, recall, F1 measure, Naïve Bayes Classifier, **Some basic statistics:** variance, covariance, bias-variance tradeoff.
UNIT-II (10 Hrs)	**Tree Models**: Decision Trees. **Linear Models**: The least-squares method: Univariate linear regression, Logistic Regression, (Except Logistic regression others Peter Flach) **Distance Based Models**: Introduction, Nearest Neighbours classification, Distance Based Clustering.
UNIT-III (10 Hrs)	**Features**: Kinds of feature, Feature transformations: Thresholding and discretisation, Normalisation, Incomplete Features, Feature construction and selection. **Model ensembles**: Bagging, random forests, **Boosting**: AdaBoost.
UNIT-IV	**Dimensionality Reduc**tion: PCA

(08 Hrs)	**Model Evaluation and Optimization**: Cross Validation, Grid Search, Regularization
UNIT-V (10 Hrs)	**Neurons, NNs, Linear Discriminants**: The Neuron, Neural Networks, The perceptron, **Multilayer perceptrons**: Going forwards, Going backwards: Backpropagation of error, Examples of using MLP. **Reinforcement Learning:** Overview, Example, Markov Decision Process, Values, Uses of Reinforcement Learning

Text Books:	
1.	Introduction to Machine Learning, Alpaydin E, MIT Press (2014) 3rdEdition
2.	Machine Learning: The art and science of algorithms that make sense of data, Peter Flach, Cambridge, 2012
3.	Machine Learning: An algorithmic perspective, Stephen Marsland, 2nd edition, CRC press, 2014.
4.	Python Machine Learning Cookbook-Practical Solutions from Preprocessing to Deep Learning, Chris Albon, Oreilly, 2018.
Reference Books:	
1.	The elements of statistical learning, Data Mining, Inference and Prediction, Trevor Hastie, Robert Tibshirani, Jerome Friedman, Second edition , Springer, 2009.
2.	Machine Learning in Action, Peter Harington, 2012, Cengage.
3.	Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, Tensorflow, Sebastian Raschka, Vahid Mirjalili, Second edition, 2020
Online MOOC Courses:	
1.	"Machine Learning" course by Andrew Ng on Coursera
2.	"Introduction to Machine Learning (IITKGP)" by Prof. Sudeshna Sarkar, on Swayam
3.	"Machine Learning A-Z (Python & R in Data Science Course)" on Udemy
Useful Reference Links:	
1.	"Linear Discriminant Analysis", https://sebastianraschka.com/Articles/2014_python_lda.html
2.	"Principal Component Analysis versus Linear Discriminant Analysis", https://medium.com/analytics-vidhya/illustrative-example-of-principalcomponent-analysis-pcavs-linear-discriminant-analysis-lda-is-105c431e8907
3.	"A gentle introduction to K-fold cross validation", https://machinelearningmastery.com/k-foldcross-validation/
4.	Grid search for model tuning", https://medium.com/analyticsvidhya/illustrative-example-ofprincipal-component-analysis-pca-vs-lineardiscriminant-analysis-lda-is-105c431e8907
5.	"Regularization in Machine Learning", https://towardsdatascience.com/regularization-inmachine-learning76441ddcf99a

Code	Category	L	T	P	C	I.M	E.M	Exam
B20CSOE09	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

DATA SCIENCE

(Offered by CSE)

(Offered to CE, ECE, EEE & ME)

Course Objectives:

1.	Provide you with the knowledge and expertise to become a proficient data scientist
2.	Understanding of statistics and machine learning concepts that are vital for data science
3.	Learn to statistically analyze a dataset
4.	Explain the significance of exploratory data analysis (EDA) in data science
5.	Evaluate data visualizations based on their design and use for communicating stories from data

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Use R to carry out basic statistical modeling and analysis	K3
2.	Apply basic tools (plots, graphs, summary statistics) to visualization of data	K3
3.	Illustrate Gradient Descent methods	K3
4.	Apply various techniques for getting and Manipulating data	K3
5.	Describe machine learning for the Data Science Process	K3

SYLLABUS

UNIT-I (12 Hrs)	**Introduction**: Getting Python, Virtual Environments, Whitespace Formatting, Modules, Functions, Strings, Exceptions, Lists, Tuples, Dictionaries defaultdict, Counters, Sets, Control Flow, Truthiness, Sorting, List Comprehensions, Automated Testing and assert, Object-Oriented Programming
UNIT-II (10 Hrs)	**Visualizing Data**: matplotlib, Bar Charts, Line Charts, Scatterplots. Linear Algebra: Vectors, Matrices, Statistics: Describing a Single Set of Data
UNIT-III (10 Hrs)	**Gradient Descent**: The Idea Behind Gradient Descent, Estimating the Gradient, Using the Gradient, Choosing the Right Step Size, Using Gradient Descent to Fit Models, Minibatch and Stochastic Gradient Descent.
UNIT-IV (08 Hrs)	**Getting Data**: stdin and stdout, Reading Files, Scraping the Web, Using APIs, **Working with Data:** Exploring Your Data Using Named Tuples, Data classes, Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction.
UNIT-V (10 Hrs)	**Machine Learning**: Modeling, Overfitting and Underfitting, Correctness, The Bias-Variance Tradeoff, Feature Extraction and Selection, k-Nearest Neighbors, Naive Bayes, Simple Linear Regression

Text Books:	
1.	Joel Grus, “Data Science From Scratch”, OReilly.
2.	Allen B.Downey, “Think Stats”, OReilly.
Reference Books:	
1.	Doing Data Science: Straight Talk From The Frontline, 1st Edition, Cathy O’Neil and Rachel Schutt, O’Reilly, 2013
2.	Mining of Massive Datasets, 2nd Edition, Jure Leskovek, Anand Rajaraman and Jeffrey Ullman, v2.1, Cambridge University Press, 2014
3.	“The Art of Data Science”, 1st Edition, Roger D. Peng and Elizabeth matsui, Lean Publications, 2015
4.	“Algorithms for Data Science”, 1st Edition, Steele, Brian, Chandler, John, Reddy, Swarna, springers Publications, 2016
e-Resources:	
1.	https://github.com/joelgrus/data-science-from-scratch
2.	https://github.com/donnemartin/data-science-ipython-notebooks
3.	https://github.com/academic/awesome-datascience

Code	Category	L	T	P	C	I.M	E.M	Exam
B20ECOE05	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

DIGITAL SIGNAL PROCESSING

(Offered by: ECE)

(Offered to AIDS, CE, CSBS, CSE, EEE, IT & ME)

Course Objectives:

1.	This course introduces students to the fundamental principles of Digital Signal Processing and develops essential analysis and design tools required for signal processing systems & implementations
2.	This subject is an introduction to the graduate-level courses in a broad range of disciplines spanning communications, speech processing & image processing.

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Describe the DSP fundamentals and. Carry-out LTI system analysis using convolution & Z-transform	K2
2.	Carryout data analysis & spectrum analysis using FFT	K3
3.	Design of FIR digital filters to meet specifications	K3
4.	Illustrate about DSP applications	K2
5.	Illustrate multirate signal processing aspects	K2

SYLLABUS

UNIT-I (10Hrs)	**Discrete-Time Signals and Systems:** Introduction to Digital Signal Processing, Basic elements of a DSP system, Advantages of Digital SP over Analogy SP, Discrete-time signals and systems, DT-LTI systems described by Linear constant–coefficient difference equations, Properties & Analysis of DT-LTI systems, Discrete linear convolution, Review of the Z-transform, Properties, Inverse Z-transform, Analysis of DT-LTI systems in Z-Domain, System function, One-sided Z-transform, Solution of difference equations, Structures and Realization of Digital Filters, Direct-I, II, series and parallel forms.
UNIT-II (10 Hrs)	**Discrete Fourier Transform (DFT) and Fast Fourier Transform Algorithms (FFT):** DFT, Properties of DFT, Circular and linear convolution of sequences using DFT, Radix–2 Decimation–in–Time (DIT) & Decimation–in–Frequency (DIF) FFT Algorithms, Inverse FFT.
UNIT-III (10 Hrs)	**Design of FIR Digital Filters:** Characteristics of FIR Digital Filters, Design of Linear Phase FIR digital Filters using Windows, Criteria for selecting appropriate window function, Design examples,

	Comparison of IIR and FIR Filters
UNIT-IV (10 Hrs)	**DSP Applications** Overview of DSP applications, Spectral analysis of sinusoidal signals using FFT, Subband coding of speech signals, DTMF Signalling.
UNIT-V (10 Hrs)	**Fundamentals of Multirate Digital Signal Processing:** Introduction to Multirate DSP, Basic sampling rate alteration devices: upsampler, downsampler, Time and Frequency domain characterization of up/down samplers, Interpolator and decimator

Textbooks:	
1.	Alan V. Oppenheim, Ronald W. Schafer, "**Digital Signal Processing**" – PHI Ed., 2006
2.	John G. Proakis, D.G. Manolakis, "**Digital Signal Processing: Principles, Algorithms and Applications"**, 3rd Ed., PHI, 1996.
Reference Books:	
1.	Sanjit K. Mitra, "**Digital Signal Processing: A Computer Based Approach**", Tata McGraw Hill.
2.	Lawrence R. Rabiner, Bernard Gold, "**Theory and application of digital signal processing",** Prentice Hall.
e-Resources	
1.	https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/index.html
2.	https://nptel.ac.in/courses/117/102/117102060/

Code	Category	L	T	P	C	I.M	E.M	Exam
B20ECOE06	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

IMAGE PROCESSING

(Offered by ECE)

(Offered to AIDS, CE, CSBS, CSE, EEE, IT &ME)

Course Objectives:

1.	To introduce fundamentals of digital image processing and study image transforms
2.	To demonstrate digital image processing techniques in spatial and frequency domains
3.	To study advanced image analysis methods: image segmentation, morphological image processing

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Understand the basic principles of digital image processing and perform image transforms.	K2
2.	perform basic image processing methods such as Image filtering operations, Image enhancement.	K3
3.	Analyze and compare various image compression techniques and their applications	K4
4.	Design and implement various algorithms for image analysis	K4

SYLLABUS

UNIT-I (10Hrs)	**Fundamentals of Image Processing:** Digital Image Fundamentals, Basic steps of Image Processing System, Sampling and Quantization of an image, relationship between pixels, Imaging Geometry. Image Transforms: 2 D- Discrete Fourier Transform, Discrete Cosine Transform (DCT)
UNIT-II (10 Hrs)	**Image Enhancement:** Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters. Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Selective filtering.
UNIT-III (10 Hrs)	**Image Segmentation:** Segmentation concepts, Point, Line and Edge Detection, Edge Linking using Hough Transform, Thresholding, Region Based segmentation. Wavelet based Image Processing: Introduction to wavelet Transform
UNIT-IV (10 Hrs)	**Image Compression:** Image compression fundamentals - Coding Redundancy, Spatial and Temporal redundancy, Compression models: Lossy and Lossless, Huffman coding, Arithmetic coding.

UNIT-V (10 Hrs)	**Image Restoration:** Image Restoration Degradation model, Algebraic approach to restoration, Inverse Filtering. **Morphological Image Processing**: Dilation and Erosion, Opening and closing, the hit or miss Transformation, some basic morphological algorithms.

Textbooks:	
1.	Digital Image Processing, Rafael C. Gonzalez and Richard E.Woods, 4thEdition, Pearson, 2018
2.	Digital Image Processing, S.Jayaraman, S. Esakkirajan, T. Veerakumar, 5th Edition, TMH, 2015
Reference Books:	
1.	Digital Image Processing, William K.Pratt, 3rdEdition, John Willey, 2007
2.	Fundamentals of Digital Image Processing, A.K.Jain, 3rd Edition, PHI, 1989
e-Resources	
1.	https://onlinecourses.nptel.ac.in/noc19_ee55/preview
2.	https://www.digimat.in/nptel/courses/video/117105135/L01.html

Code	Category	L	T	P	C	I.M	E.M	Exam
B20EEOE02	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs**

MATLAB PROGRAMMING FOR ENGINEERING APPLICATIONS

(Offered by EEE)

(Offered to AIDS, CE, CSBS, CSE, IT & ME)

Course Objectives: Students will learn

1.	About the MATLAB basics, built-in functions, matrix operations, plotting commands.
2.	Conditional and looping statements to write MATLAB programs.
3.	About the different statistical approaches for better interpretation of data using MATLAB.
4.	About the MATLAB programming to solve engineering systems described by the mathematical equations.
5.	About the MATLAB programming for numerical methods.

Course Outcomes: Students will be able to

S.No	Outcome	Knowledge Level
1.	**Use** the built-in functions, matrix operations, plotting commands, arithmetic operations in MATLAB programs.	K3
2.	**Apply** the conditional and looping statements to write MATLAB programs.	K3
3.	**Apply** different statistical approaches for better interpretation of data using MATLAB.	K3
4.	**Apply** MATLAB programming to solve engineering systems described by the mathematical equations.	K3
5.	**Apply** MATLAB programming for numerical methods.	K3

SYLLABUS

UNIT-I (10 Hrs)	**INTRODUCTION TO MATLAB** History, purpose and importance, data types, conversion of data types, operators, built-in functions, creating vectors, matrices, manipulation of vectors and matrices, Matrix Operations, addition, subtraction, multiplication, transpose, Inverse, Determinant, Identity matrix, using simple xy Plotting Functions, line plots, subplots, bar plots, surface plots, pie plots, Saving and loading data.
UNIT-II (10 Hrs)	**MATLAB PROGRAMMING** Program Design and Development, Relational Operators and Logical Variables, Logical Operators, If statement, Else-if statement, Else statement, Switch Statement, For Loops, While Loops, Debugging MATLAB Programs, Simple programming examples.
UNIT-III	**STATISTICS, PROBABILITY AND INTERPOLATION**

(10 Hrs)	Statistics and Histograms, The Normal Distribution, Mean, Mode, Median and Standard Deviation, Uniformly Distributed Numbers, Normally Distributed Random Numbers, Generating Random Integers, Interpolation, Two-Dimensional Interpolation, curve fitting using least square method.
UNIT-IV (10 Hrs)	**SOLVING EQUATIONS** Linear algebra, Rank, Eigen values, Eigen vectors, Linear algebraic equations solving using matrices (up to three variables), Gauss elimination method, Matrix inverse method, quadratic equation, ordinary differential equation (upto second order), solution of partial differential equation (two variable).
UNIT-V (10 Hrs)	**NUMERICAL METHODS** Gauss Seidel method, Newton Raphson method for solving nonlinear equations, Rungekutta-4 method for solving ordinary differential equations, Trapezoidal method for solving numerical integration.
Text Books:	
1.	MATLAB and Simulink Crash Course for Engineers by Eklas Hossain, Oregon Institute of Technology Klamath Falls, OR, USA, Springer publication, 2022.
2.	Applied Numerical Methods Using MATLAB, by Won Young Yang Chung, Wenwu Cao, Tae-Sang Chung, John Morris, A John Wiley & Sons, Inc., Publication, 2005
Reference Books:	
1.	MATLAB ® for Engineering Applications by William J. Palm III, Fourth edition, New York, NY: McGraw-Hill Education, 2018.
2.	MATLAB Programming for Engineers, Stephen J.Chapman, third edition, Thomson Learning publication, 2005.

Code	Category	L	T	P	C	I.M	E.M	Exam
B20ITOE05	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

CLOUD COMPUTING

(Offered by IT)

(Offered to CE, ECE, EEE & ME)

Course Objectives: Students are expected to

1.	Examine the system models for cloud computing.
2.	Understand the concepts of virtualization, hardware and storage
3.	Identify cloud platform architecture and programming.
4.	Develop cloud applications

Course Outcomes: After completion of the course, the student will be able to

S.No	Outcome	Knowledge Level
1.	**Define, understand,** and **explain** the concepts of cloud computing environment and various Virtualization techniques.	K2
2.	**Explore and understand** various services provided by Cloud Computing	K2
3.	**Illustrate** various Cloud application development frame	K2
4.	**Understand** various cloud maintenance techniques.	K2
5.	**Develop** a cloud-based applications by applying Amazon, Microsoft, Salesforce.com etc., frameworks.	K4

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to cloud computing**: Cloud computing components, Infrastructure services, storage applications, database services – introduction to SaaS, PaaS, IaaS, IdaaS, data storage in cloud. **Virtualization**: enabling technologies, types of virtualization, server virtualization, desktop virtualization, memory virtualization, application and storage virtualization-tools and products available for virtualization.
UNIT-II (10 Hrs)	**SAAS and PAAS**: Getting started with SaaS, SaaS solutions, SOA, PaaS and benefits. **IaaS and Cloud Data Storage**: understanding IaaS, improving performance for load balancing, server types within IaaS, utilizing cloud based NAS devices, cloud based data storage, and backup services, cloud based block storage and database services.
UNIT-III (12 Hrs)	**Cloud Application development**: Client server distributed architecture for cloud designing cloud based solutions, coding cloud based applications, traditional Apps vs cloud Apps, client side programming, server side programming overview fundamental treatment of web application frameworks.

UNIT-IV (12 Hrs)	**Cloud Governance and economics**: Securing the cloud, disaster recovery and business continuity in the cloud, Managing the cloud, migrating to the cloud, governing and evaluating the clouds business impact and economics.
UNIT-V (10Hrs)	**Inside Cloud**: Introduction to MapReduce and Hadoop-over view of big data and its impact on cloud. **Google**: Google App Engine, Google Web Toolkit **Microsoft**: Azure Services Platform, Windows live, Exchange Online, Share Point Services
Textbooks:	
1.	Cloud Computing: SaaS, PaaS, IaaS, Virtualization, Business Models, Mobile, Security and More, Kris Jamsa, Jones & Bartlett Publishers, Paper back edition,2013
2.	Cloud Computing, A Practical Approach, 1st Edition, Anthony T Velte, Toby J Velte, Robert Elsenpeter, TMH,2017
Reference Books:	
1.	Hadoop MapReduce cookbook, Srinath Perera and Thilina Gunarathne, Packet publishing.
e-Resources	
1.	https://onlinecourses.nptel.ac.in/noc21_cs15/preview

Code	Category	L	T	P	C	I.M	E.M	Exam
B20MEOE07	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

GREEN ENERGY SYSTEMS

(Offered by ME)

(Offered to AIDS, CE, CSBS, CSE, ECE & IT)

Course Objectives:

1.	Significance of alternative sources of energy.
2.	Significance of green energy systems and processes and provides the theory and working principles of probable sources of renewable and green energy systems that are environmental friendly.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	Explain the importance of solar energy and solar energy collection	K2
2.	Apply the principles of solar energy storage systems and wind energy.	K3
3.	Apply the principles of biomass, geothermal and ocean energies & their potential future applications.	K3
4.	Describe the principles of energy efficient systems like electrical and mechanical systems.	K2
5.	Discuss the concepts of green manufacturing systems.	K2

SYLLABUS

UNIT-I (10 Hrs)	**INTRODUCTION:** Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power. **SOLAR RADIATION**: the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data **SOLAR ENERGY COLLECTION**: Flat plate and concentrating collectors, classification of concentrating collectors, Photo voltaic energy conversion – types of PV cells.
UNIT-II (10 Hrs)	**SOLAR ENERGY STORAGE AND APPLICATIONS**: sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, central power tower concept. **WIND ENERGY**: Sources and potentials, horizontal and vertical axis windmills.
UNIT-III (10 Hrs)	**BIO-MASS:** Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters

	GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy. **OCEAN ENERGY**: OTEC, Principles of utilization, setting of OTEC plants.
UNIT-IV (10 Hrs)	**ENERGY EFFICIENT SYSTEMS**: ELECTRICAL SYSTEMS: Energy efficient motors, Controls for HVAC (heating, ventilation and air conditioning). **MECHANICAL SYSTEMS:** Fuel cells- principle, selection of fuels & working of various types of fuel cells, Environmental friendly and Energy efficient compressors and pumps.
UNIT-V (10 Hrs)	**GREEN MANUFACTURING SYSTEMS**: Environmental impact of the current manufacturing practices and systems, benefits of green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, vegetable based cutting fluids, alternate casting and joining techniques, zero waste manufacturing.

Text Books:	
1.	Non-Conventional Energy Sources - G. D. Rai, fifth edition, Khanna Publishers, 2015.
2.	Non-Conventional Energy Resources - Khan B.H., Tata McGraw Hill, New Delhi, 2006
3.	Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P.and J.K.Nayak/TMH
4.	Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013.
Reference Books:	
1.	Alternative Building Materials and Technologies - K.S Jagadeesh, B.V Venkata Rama Reddy and K.S Nanjunda Rao/New Age International
2.	Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
3.	Renewable Energy Technologies -Ramesh & Kumar /Narosa
4.	Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth & John F Kreider/Taylor & Francis.
5.	Fuel Cell Technology -Hand Book / Gregor Hoogers / BSP Books Pvt. Ltd
e-Resources:	
1.	https://nptel.ac.in/courses/103103206
2.	https://nptel.ac.in/courses/115103123

Code	Category	L	T	P	C	I.M	E.M	Exam
B20MEOE08	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

TOTAL QUALITY MANAGEMENT

(Offered by ME)

(Offered to AIDS, CE, CSBS, CSE, ECE EEE & IT)

Course Objectives:

1.	To provide a detailed knowledge and information about total quality management.
2.	To develop the ability to choose and integrate various strategies to implement quality on a continuous improvement basis.
3.	To provide the required knowledge of techniques to partake in and play a significant role in the implementation of a total quality management system and to evaluate the performance measures in the organisation, in turn supporting career growth and progression.

Course Outcomes: At the end of the course, student will be able to:

S.No	Outcome	Knowledge Level
1.	Understand the basic concepts of TQM and its significance in present day business context.	K2
2.	Understand various principles and philosophies of TQM and how they can be applied within quality management systems.	K2
3.	Implement the TQM approach in an organization for continuous quality improvement by choosing appropriate strategies.	K2
4.	Apply different techniques for analyzing the performance of the company across various measures.	K3
5.	Select and use appropriate tools and techniques for implementing quality in an organization.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to TQM:** Definition of quality and total quality management (TQM) - basic approach, TQM framework; contribution of quality gurus in TQM journey, obstacles in implementing TQM, benefits of TQM.
UNIT-II (10 Hrs)	**Principles and Philosophies:** Deming's philosophy as a framework for TQM; Quality council – duties, quality statements of an organization; Customer satisfaction – customer perception of quality, translating customer needs into requirements, customer retention; Unions and employee involvement – benefits.
UNIT-III (10 Hrs)	**Continuous Process Improvement:** Process – Input/output process model, Approaches to continuous process improvement - Juran's triology, Shewart's PDSA cycle, Kaizen.

UNIT-IV (10 Hrs)	**Performance Measures:** Introduction and Objectives; Presentation of performance measures: Control charts for variables and attributes – construction of $\bar{X}$ and R charts, p chart and c chart; Taguchi's loss function – nominal the best; Quality cost – failure costs, prevention and appraisal costs.
UNIT-V (10 Hrs)	**Tools and Techniques:** Quality function deployment (QFD) – Benefits, House of quality (HOQ), building a HOQ, QFD process; Quality and Environmental management systems – Introduction to ISO 9001 and ISO 14001.
Text Books:	
1.	Dale H. Besterfield et al, Total Quality Management, Third edition, Pearson Education (First Indian Reprints 2004).
2.	Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002.
Reference Books:	
1.	Total Quality Management by P. N. Mukherjee, Prentice Hall of India Private Limited, 2006.
2.	Total Quality Management by Dr. K.C. Arora, S. K. KATARIA & SONS
3.	Total Quality Management by Suganthi L and Anand Samuel
4.	Total Quality Management - Text and Cases" by Janakiraman B and Gopal R K

Code	Category	L	T	P	C	I.M	E.M	Exam
B20MEOE09	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

SUPPLY CHAIN MANAGEMENT

(Offered by ME)

(Offered to AIDS, CE, CSBS, CSE, ECE EEE & IT)

Course Objectives:

1.	To develop an understanding of basic concepts of supply chain management and its drivers to achieve business excellence.
2.	To develop analytical and critical understanding & skills for planning, designing and operations of supply chain.
3.	To develop sustainability consciousness into supply chain operations.

Course Outcomes: At the end of the course, student will be able to:

S.No	Outcome	Knowledge Level
1.	Illustrate the impact of supply chain activities and decisions on supply chain performance.	K2
2.	Understand the role and applications of different drivers in a supply chain.	K2
3.	Analyze various distribution networks that help in supply chain network design decisions.	K2
4.	Understand the fundamentals of managing and coordinating supply and demand and its impact on supply chain performance.	K2
5.	Understand the importance of sustainability in supply chains in today's business context.	K2

SYLLABUS

UNIT-I (10 Hrs)	**Fundamentals of Supply Chain:** Supply chain: definition, objective, decision phases, process views, and macro processes; Strategic fit: how to achieve it and the challenges in achieving it.
UNIT-II (10 Hrs)	**Supply Chain Drivers and Metrics:** Impellers of supply chain developments; Logistical and Cross functional drivers of supply chain performance: Roles, Components of their decisions, and Metrics.
UNIT-III (10 Hrs)	**Supply Chain Network:** The role of distribution in the supply chain, factors influencing distribution network design, design options for a distribution network (manufacturer storage with direct shipping and manufacturer storage with direct shipping and in-transit merge), role of network design in the supply chain, factors influencing network design decisions.
UNIT-IV	**Coordination in a Supply Chain:** Supply chain coordination and Bull-whip effect, impact on

(10 Hrs)	performance of lack of coordination, obstacles for coordination and levers to help achieve it; CRP and VMI.
UNIT-V (10 Hrs)	**Sustainability and the Supply Chain:** Role of sustainability in the supply chain; key metrics for sustainability; role of supply chain drivers in improving sustainability; closed loop supply chains.

Text Books:	
1.	Chopra.S. & Meindl P, Supply Chain Management: Strategy, Planning & Operation, Pearson Education, 3rd Edition, 2006, ISBN: 0131730428.
2.	Simchi- Levi Davi Kaminasky Philip & Simchi- Levi Edith, Designing & Managing the Supply Chain, Tata McGraw-Hill Publishing Company Ltd., 3rd Edition, 2008, ISBN: 9780070666986.
Reference Books:	
1.	Supply Chain Management: Text and cases Shah. J (2009), Pearson, New Delhi
2.	Logistics Management- The Supply Chain Imperative Sople V. Vinod, Pearson Education
3.	Business Logistics/Supply Chain Management Ballou Srivastava, Pearson Education

Code	Category	L	T	P	C	I.M	E.M	Exam
B20BSOE03	**OE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

MATHEMATICAL MODELING FOR DATA SCIENCE (MMDS)

(Offered by EM&H)

(Offered to CE, CSBS, CSE, ECE, EEE, IT & ME)

Course Objectives: Students are expected to

1	Learn Joint random variables and Markov process and its properties.
2	Understand various queuing systems and their applications.
3	Have an idea on Generation of random numbers and its applications in various domains.
4	Forecast trend by using by various methods of Time series data.
5	Analyze the data thorough simple and multiple regression techniques.

Course Outcomes: At the end of the course students will be able to

S. No	OUT COME	Knowledge Level
1	Find the Joint and conditional probabilities and apply them to a Stochastic process	K3
2	Identify various queuing models and find its solutions.	K3
3	Distinguish different simulation models and solve them	K3
4	Predict the trend values of a time series data using forecasting methods.	K3
5	Compute the data with the help of regression techniques	K3

SYLLABUS

UNIT-I (10 Hrs.)	**Stochastic Process: -** Random variables, Joint probability distribution, conditional probability distribution, marginal probabilities, concept of random process (stochastic process), Classification of process, Statistical independence, Markov chain, Stochastic matrix-properties (without proof). Transition probabilities: One-step & n-step transition probabilities.
UNIT-II (10 Hrs.)	**Queuing Models: -** Queuing system, Characteristics, Transient and steady states, Probability distribution in queuing systems, Poison process, Kendall's notation. Classification of queuing models - (M/M/1): (∞/FCFS) and (M/M/1): (N/FCFS). Introduction to Networks of queues.
UNIT-III (10 Hrs.)	**Simulation: -** Introduction to simulation, phases of simulation systems and system environment, Components of a system, discrete and continuous systems, Steps in simulation study. Generation of random numbers, Mont-Carlo simulation. **Simulation applications**- Applications to inventory control, Queuing model, Finance and Budgeting.

UNIT-IV (10 Hrs.)	**Time series Analysis: -** Introduction, utility and components of time series. Estimation and forecasting of trend by using graphic method, method of semi averages, Method of moving averages and Method of least squares.
UNIT-V (10 Hrs.)	**Regression Methods: -** Analysis of data thorough simple and multiple regression and correlation: Model assumptions, Evaluation, Uncertainties in the Least-Squares Coefficients, Inferences on the Mean Response, estimation and prediction, Prediction Intervals for Future Observations, data transformation
TEXT BOOKS:	
1.	Higher engineering mathematics by B V Ramana, MC-Graw Hill Edn.(Unit-I)
2.	Operations Research, S.D. Sharma, Kedharnath and Ramnath.-(Unit-II and Unit-III)
3	Fundamentals of applied Statistics, S.C. Gupta & V.K. Kapoor, Sultan Chand & Son's. (Unit-IV)
4	Statistics for Engineers and Scientists, William Navidi, MC-Graw Hill, Third Edition. (Unit-V)
REFERENCE BOOKS:	
1.	Probability Theory and stochastic process for engineers, K N Hari Bhat, Anitha Sheela. K, Jayant Gangula, Pearson publishers.
2	Operations Research by J.K Sharma, MACMILAN publications
3.	Discrete-event system simulation, Jerry bank, J.s. Carson, B L Nelson & David M.Nical, Prentice-Hall of India, (3rd Edition)
4.	Applied Multivariate Statistical Analysis, Richard. A. Johnson Dean. W. Wkhern. (6th Edition)