DEPARTMENT OF COMPUTER ENGINEERING

College of Electrical and Mechanical Engineering (CEME)

National University of Sciences and Technology (NUST)

1. Course Information	
Course Number and Title:	EC-835 Digital Image Processing
Credits:	3
Instructor(s)-in-charge:	Dr. Muhammad Usman Akram
Course type:	Lecture
Core or Elective:	Elective
Course pre-requisites	None
Degree and Semester	MS CE/CSE 2023, 01 Semester
Month and Year	Fall 2023

2. Course Schedule	
Lecture:	3 hrs/week, Meets once weekly
Lab:	N/A
Discussion:	1 hr/discussion, multiple discussion sections offered per quarter
Outside study:	3 hrs/week
Office Hours :	3 hrs/week by instructor, (Tuesday 1800-1900, Wednesday 1800-1900)

Course Assessment				
Exam:	1 Mid term and 1 Final			
Home work:	3 graded Assignments			
Lab reports:	N/A			
Design reports:	1 Design report and 1 presentation based on Semester Project			
Quizzes & Class Participation:	Regular in class discussion and questions (06-08)			
Grading:	Theory (100%)		Lab (N/A)	
	Mid term Exam	30%	Lab Work/Tasks (Every week)	NA
			Open Lab 1	NA
	Project	10%	Open Lab 2	NA
	Quizzes	10%		
	Assignments	10%		
	Final Exam	40%		
Plagiarism Policy	Any work (Assignment, Projects, labs etc) if found copied, will have strict penalties			

3. Course book and Related Course Material

Textbooks:	1. Digital Image Processing by Rafael C. Gonzalez and Woods, 4th Edition, 2018
Reference Books:	1. David A. Forsyth and Jean Ponce, Computer Vision−A Modern Approach, 2. Fundamentals of Digital Image Processing: A Practical Approach with Examples in Matlab by Chris Solomon, Wiley-Blackwel, 2011 3. Digital Image Processing Using Matlab by Rafael C. Gonzalez and Richard E. Woods, Pearson Education, 2009. 4. Digital Image Processing by Kenneth R. Castleman, Prentice Hall International Edition, 1996. 5. http://www.imageprocessingplace.com/

4. Catalog Descriptions

This course consists of topics related to image processing from introductory to a bit advanced level. The contents include introduction to image processing systems and applications, Image enhancement in spatial and frequency domains, removal of noise using image restoration, analysis of images using wavelets, shape based analysis using morphological operations, thresholding and clustering based segmentation, feature extraction such as edges, corners and texture based features and image classification. This also includes basic introduction and implementation of convolutional neural networks (CNNs), Generative Networks and Transformers. All lectures are supplemented by home works and assignment based implementations of image processing tasks using Python, OpenCV and MATLAB.

5. Course Objectives

The main objectives of this course are

a) To provide a comprehensive presentation of the fundamentals of image processing and analysis both from a theoretical as well as practical point of view.

b) To familiarize the students with the techniques of image enhancement in spatial and frequency domain.

c) To introduce the students to the image restoration techniques.

d) To familiarize students with the basic concepts relating to the color image processing.

e) To provide broader understanding of image compression, image morphology and wavelets.

f) To give them an idea about low and high level feature extraction from images and to apply classification in order to make decision support system for image processing based applications

g) To enable students to implement all theoretical information gained during the lectures in Python or MATLAB and also to program solutions in Python or MATLAB to practical problems.

6. Topics covered in the Course and Level of Coverage	
1. Introduction to image processing and it fundamentals **a. Basics of image processing** **b. Image resolution** **c. Connected component analysis**	4 hrs
2. Image enhancement in spatial domain **a. Intensity transformations** **b. Histogram and its analysis** **c. Convolution and spatial filtering**	8 hrs
3. Edge Detection and analysis **a. Edge segmentation (magnitude and Phase Analysis)** **b. Hough Transform**	3 hrs
4. Segmentation using thresholding and clustering **a. Global, local and adaptive thresholding** **b. K-means clustering** **c. Region growing and splitting based segmentation**	3 hrs
5. Morphological operations for binary and gray images **a. Introduction to morphological operations** **b. Morphological operation for binary images** **c. Gray level morphological operations**	2 hrs
6. Color image processing **a. Formation of color image** **b. Different color models** **c. Analysis of colored images**	2 hrs
8. Texture Analysis **a. Statistical descriptors** **b. GLCM analysis** **c. Spectral descriptors**	2 hrs
9. Descriptors **a. Local Binary Pattern** **b. Histogram of oriented gradients**	3 hrs
10. Machine Learning & Classification a. Lecture b. In lab hands on	6 hrs
11. Deep Learning **a. Basic concepts of CNNS** **b. Calculating parameters and layer size for CNN architectures** **c. Introduction to segmentation and object detection**	9 hrs

d. In lab hands on	
12. Generative Networks	3 hrs
13. Transformers	3 hrs

7. Course Outcomes

Course Learning Outcome			
Understanding the fundamentals and basic concepts of image processing related to image enhancement, filtering and segmentation etc			
Performing different mathematical transformations, histogram based operations and filtering concepts for solving image enhancement and feature extraction problems			
Combining the concepts of image processing with machine learning to **analyze and design** decision support systems for image processing based applications			
Learning the use of MATLAB/Python and OpenCV to **implement** basic image processing algorithms and to **solve** real life and open ended problems			

DEPARTMENT OF COMPUTER
& SOFTWARE ENGINEERING
College of Electrical and Mechanical Engineering (CEME)
National University of Sciences and Technology (NUST)

1. Course Information	
Course Number and Title:	Software Requirements Engineering
Credits:	3
Instructor(s)-in-charge:	Associate Professor Dr Wasi Haider Butt
Course type:	Lecture
Required or Elective:	Required
Course pre-requisites	
Degree and Semester	MS-CSE-23, First
Month and Year	Fall 2023

2. Course Schedule	
Lecture:	3 hrs/week, Once weekly
Discussion:	1 hr/discussion, multiple discussion sections offered per quarter

3. Course Assessment		
Exam:	1 Mid Term and 1 Final	
Home work:	1 Survey Paper	
Design reports:	1 Software Requirements Specifications Report	
Quizzes:	6 Quizzes	
Grading:	Quizzes:	10%
	Projects + Assignments:	10%
	1 Mid Term:	30%
	Final Exam:	50%

4. Course book and Related Course Material	
Textbooks:	1. Software Requirements, Karl E. Wiegers, Latest Edition, Microsoft Press, Latest Edition 2. More About Software Requirements: Thorny Issues and Practical Advice, Karl E. Wiegers, Microsoft Press, Latest Edition
Reference Books:	1. Software Requirements Using The Unified Process: A Practical Approach, Daniel R. Windle and L. Rene Abreo, Prentice Hall, Latest Edition 2. Mastering the Requirements Process, Suzanne Robertson & James Robertson, Addison-Wesley, Latest Edition. 3. Managing Software Requirements: A Use Case Approach, Dean Leffingwell and Don Widrig , Latest Edition, Addison Wesley, Latest Edition

5. Topics covered in the Course and Level of Coverage	
• **Intro & Basic concepts of SR Engineering.**	3 Hrs
• **Social And Cultural Issues in RE**	3 Hrs
• **Role of Req Engineer**	3 Hrs
• **Types of Software Requirements**	3 Hrs
• **Requirement Elicitation**	3 Hrs
• **Elicitation Techniques**	3 Hrs
• **Requirement Analysis**	3 Hrs
• **Analysis & Negotiation**	3 Hrs
• **Requirement Specifications**	3 Hrs
• **Ways of writing requirements**	3 Hrs
• **Requirements Validation**	3 Hrs
• **Validation Techniques**	3 Hrs
• **Requirements Management 1**	3 Hrs
• **Requirements Management 2**	3 Hrs
• **Requirements Engineering Process Improvement**	3 Hrs
• **Modern Tools Techniques in RE**	3 Hrs

DEPARTMENT OF COMPUTER ENGINEERING

College of Electrical and Mechanical Engineering (CEME)

National University of Sciences and Technology (NUST)

1. Course Information	
Course Number and Title:	SE-868 Software Project Management
Credits:	3
Instructor(s)-in-charge:	Assistant Professor Dr Mehwish Naseer
Course type:	Lecture
Required or Elective:	Elective
Course pre-requisites	
Degree and Semester	MS-CSE-22, MS-CSE-23 (Third and First)
Month and Year	Fall 2023

2. Course Schedule	
Lecture:	3 hrs/week, Once weekly
Discussion:	1 hr/discussion, multiple discussion sections offered per quarter

3. Course Assessment		
Exam:	1 Mid Term and 1 Final	
Home work:	3 Assignments	
Term Paper:	1 Term Paper as Semester Project	
Quizzes:	6 Quizzes	
Grading:	Quizzes:	10%
	Term Paper + Assignments:	10%
	1 Mid Term:	30%
	Final Exam:	50%

4. Course book and Related Course Material	
Textbooks:	1. Software Project Management, Bob Hughes and Mike Cotterell, McGraw-Hill Education; (Latest Edition). 2. A Guide to the Project Management Body of Knowledge, (PMBOK Guides), (Latest Edition).
Reference Books:	1. Mastering Software Project Management: Best Practices, Tools and Techniques, Murali K. Chemuturi and Thomas M. Cagley Jr., J. Ross Publishing, (Latest Edition). 2. Effective Project Management: Traditional, Agile, Extreme, Robert K. Wysocki, Wiley; (Latest Edition).

5. Topics covered in the Course and Level of Coverage	
• **Intro to Software Project Management**	3 Hrs
• **Project Management Tools**	3 Hrs
• **PMI Framework/ Knowledge Areas**	3 Hrs
• **Organizational Structure**	3 Hrs
• **Project Planning**	3 Hrs
• **Project Evaluation**	3 Hrs
• **Project Selection**	3 Hrs
• **Software Effort Estimation**	3 Hrs
• **Activity Planning**	3 Hrs
• **Software Risk Management**	3 Hrs
• **Resource Allocation**	3 Hrs
• **Monitoring and Control**	3 Hrs
• **Managing Contracts**	3 Hrs
• **Managing people in software environments**	3 Hrs
• **Working in Teams**	3 Hrs
• **Software Quality**	3 Hrs

DEPARTMENT OF COMPUTER ENGINEERING

College of Electrical and Mechanical Engineering (CEME)

University of Sciences and Technology (NUST)

1. Course Information	
Course Number and Title:	CE-820 Advanced Computer Architecture
Credits:	3-0
Instructor(s)-in-charge:	Dr. Farhan Hussain
Course type:	Lecture
Required or Elective:	Required (Core)
Course pre-requisites	None
Degree and Semester	MS 2023
Month and Year	Fall 2023

2. Course Schedule	
Lecture:	3 hrs/week, Meets Once weekly
Office Hours :	3 hrs/week by instructor

3. Course Assessment		
Exam:	1 Mid Term and 1 Final	
Grading(Tentative):	Quizzes:	15%
	Assignments:	5%
	1 Mid Term:	30%
	Final Exam:	40%
	Project	10%

4. Course book and Related Course Material	
Textbooks:	1. Computer Architecture: A Quantitative Approach Book by David A Patterson and John L. Hennessy

5. Topics covered in the Course and Level of Coverage	
a. Computer Architecture Overview	
b. Single instruction single data (SISD) implementation	
c. Implementation of Pipelining and superscalar processor	
d. Multiple static issue and multiple dynamic issue processors	
e. Dependencies (Control, structure and data)	

f. Static Scheduling and Dynamic Scheduling	
g. Out of order (OoO) Execution	
h. Advanced Branch Predictions	
i. Trace Scheduling	
j. Cache coherence, Memory consistency in multicore processors	
k. Advanced Cache Optimizations	
l. Intro to GPU architectures and parallel processing.	

National University of Sciences & Technology (NUST)
College of Electrical and Mechanical Engineering (CE&ME)
Department of Computer & Software Engineering

Machine Learning			
Course Code:	CSE-804	**Semester:**	3rd
Credit Hours:	3	**Prerequisite Codes:**	Basic knowledge of Linear Algebra, Partial Derivatives, and Matlab/Python
Instructor:	Dr. Ali Hassan	**Class:**	MS
Office:	DCE-17	**Telephone:**	--
Lecture Days:	Tue	**E-mail:**	alihassan@ce.ceme.edu.pk
Class Room:	CRC-11	**Consulting Hours:**	Thursday Before Class or Email
Lab Engineer:	NA	**Lab Engineer Email:**	NA

Course Objectives:

This course has been designed to introduce the graduate students to a very active area of research in Machine Learning. In this course the students are introduced with the mathematical background of the tools available that can be used to implement any pattern recognition system.

Grading	Distribution
Mid Term	30%
Final	40%
Assignments 4-6	10%
Quizzes 4-6	10%
Project	10%
Total	100%

Books:

Text Book:
1. Machine Learning A Probabilistic Perspective by Kevin Murphy

Reference Books:
1. Pattern Classification (2nd Edition) by Riachard Duda, Peter Hart and David Stork
2. Pattern Recognition and Machine Learning by Christopher Bishop
3. Lecture notes
4. Online Material Shared in the class

Topics to be Covered:

Background Knowledge

History of Machine Learning

Introduction to linear algebra

- Matrix manipulation
-
- Eigen Values and Eigen vectors
- Partial Derivatives

Optimsation

- Gradient Descent
- Lagrange Multipliers

Handling Data

- Types of Data
- Cross validation

• PCA
Machine Learning Algorithms
• Linear Regressions
• Logistic Regression
• Neural networks
• Support Vector Machines
Learning Theory
• Generalisation
• Regularisation
• Bayes Learning
Applications of Machine Learning
• Anomaly Detection
• Collaborative Filtering
• Big Data Applications
• Deep Learning

Lecture Breakdown:

Week No.	Topics	Assessments
1	• Introduction to the course • Topics to be covered	
2	• Types of Pattern Recognition (PR) • A PR system design cycle • Supervised vs Unsupervised Learning • Background to mathematics and calculus	
3	• Linear Regression with One Variable • Gradient Descent	
4	• Linear Regression with Multiple Variables ○ Polynomial Regression • Linear Regression -- Normal Equations	

5	• Regularisation
	  ○ Linear Regression
	  ○ Logistic Regression	

6	• Neural Networks
	  ○ Introduction
	  ○ Cost function
	  ○ Cost function Minimisation	

7	• Pre-Processing • Generalisation Error	
8	• Multi-class Classification • Feature Selection • Dimensionality Reduction	
	MID TERM EXAM	
9	• Un-Supervised Learning ○ Clustering	

	○ K-mean Clustering
10	• Texture Recognition • Local Binary Patterns • Homogeneous Texture
11	• Support Vector Machines SVMs ○ Linear SVMS
12	• Support Vector Machines ○ Separable Linear ○ Non-Separable Linear ○ Separable Non-Linear ○ Non-Separable Non-Linear ○ *Kernel* Trick
13	• Ensemble Methods • Combining classifiers ○ Bagging ○ Boosting ○ Ada-Boosting
14	• Genetic Algorithms
15	• Deep Learning
16	• Collaborative Filtering for Recommender Systems
17	• Big Data Applications
	ESE
Total Lectures:	

Assignments

Assign 01:	……
Assign 02:	……
Assign 03:	……
Assign 04:	……
Assign 05:	……
Assign 06:	……

Grading Policy:

Quiz Policy:	The quizzes will be unannounced and normally last for five-ten minutes. The question framed is to test the concepts involved in last few lectures. Number of quizzes that will be used for evaluation is at the instructor's discretion. Grading for quizzes will be on a fixed scale of 0 to 5. A score of 5 indicates an exceptional attempt towards the answer and a score of 1 indicates your answer is entirely wrong but you made a reasonable effort towards the solution. Scores in between indicate very good (4), good (3), satisfactory (2), and poor (1) attempt. Failure to make a reasonable effort to answer a question scores a 0.
Assignment Policy:	In order to develop comprehensive understanding of the subject, assignments will be given. Late assignments will not be accepted / graded. All assignments will count towards the total (No 'best-of' policy). The students are advised to do the assignment themselves. Copying of assignments is highly discouraged and violations will be dealt with severely by referring any occurrences to the disciplinary

	committee. The questions in the assignment are meant to be challenging to give students confidence and extensive knowledge about the subject matter and enable them to prepare for the exams.
Plagiarism:	NUST CEME maintains a zero tolerance policy towards plagiarism. While collaboration in this course is highly encouraged, you must ensure that you do not claim other people's work/ ideas as your own. Plagiarism occurs when the words, ideas, assertions, theories, figures, images, programming codes of others are presented as your own work. You must cite and acknowledge all sources of information in your assignments. Failing to comply with the NUST CEME plagiarism policy will lead to strict penalties including zero marks in assignments and referral to the academic coordination office for disciplinary action.

Tools / Software Requirement:

- Python

COLLEGE OF ELECTRICAL AND MECHANICAL ENGINEERING
NATIONAL UNIVERSITY OF SCIENCES AND TECHNOLOGY

Title	**:**	**Data Engineering**
Code	**:**	**CSE810**
Credit Hours	**:**	**3-0**
Pre Requisites	**:**	**None**

Course Objectives:

- Basic principles, techniques, tools and applications of Data Engineering. Science of Data Engineering as the automatic extraction of patterns representing knowledge stored in large databases, data warehouses, and other massive information repositories About the overlap that exists with areas such as machine learning and pattern recognition. The concepts of data pre-processing, cluster analysis, classification and prediction, frequent pattern mining and data warehousing.

Text Book

- Data Science Concepts and Techniques with Applications (2nd Edition) by Usman Qamar and Summair Raza

Reference Books

- Elements of Statistical Learning by Hastie, Tibshirani and Friedman

Detailed Contents

- Data Engineering Overview: Provide an overview of the data mining, data engineering and its applications.
- Fuzzy/Rough-sets: Introduction to rough-sets and Feature selection using rough-sets
- Classification Trees: Generate decision tress for the purpose of classification and clustering.
- Multiple Linear Regression in Data Mining: The general purpose of multiple regressions is to learn more about the relationship between several independent or predictor variables and a dependent or criterion variable.
- Curse of Dimensionality: What is curse of dimensionality, how it happens and how it might be avoided.
- Association Rules: Association rules form the backbone of data mining. Different tools and algorithms used for generating association rules are discussed.
- Frequent and Infrequent mining: Case studies of how data mining is applied in industry from market transactions (Frequent mining) to Network security (infrequent mining).
- Web Mining: Different techniques and tools used by companies such as Google to carry out web mining.

Time Schedule

- Fall Semester 2023

Name and Qualification of Faculty Conducting Course

- Dr Usman Qamar,
  PhD (University of Manchester)
  Computer Engineering Department,
  Specialization: Data Science

Software System Design & Architecture

College /School: College of Electrical and Mechanical Engineering
Program: MS Software Engineering
Course Title: Software System Design & Architecture
Course Code: CSE 861
Credits: 3(3,0)
Pre requisites: NIL

Course Objectives:

To introduce students to the fundamentals of Software Design and Architecture and to impart thorough understanding of the latest Software Engineering practices in this area.

Lessons Plan:

Foundations

1. Introduction to SSDA Landscape
2. Unified Modeling Language (UML-1) –Structural Designing Concepts
3. Unified Modeling Language (UML-2) –Dynamic Designing Concepts
4. Unified Modeling Language (UML-3) –DSL Development through UML Profiles

Model Driven Architecture

1. Introduction to SSDA Landscape
2. Model Driven Architecture in Practice
3. Metamodeling and Ecore
4. Object Constraint Language
5. Model to Text Transformation

Design Principles / Patterns

1. Strategy Design Pattern Case Study
2. Observer Design Pattern Case Study
3. Decorator Design Pattern Case Study
4. Adapter & Factory Design Pattern Case Studies
5. Singleton & Composite Design Pattern Case Studies

Software Architecture Topics

1. Middleware Technologies -1
2. Middleware Technologies -2
3. Software Architecture Process

Time Schedule: Fall 2023

Text / Reference Books:

1. Software Engineering, Ian Sommerville, 7 Edition, Addison Wesley, 2015.
2. Pattern-oriented Software Architecture (POSA) Vol 1-5
3. Essential Software Architecture, Ian Gorton, Springer 2011
4. Material and Research Papers from ACM, Springer, IEEE

DEPARTMENT OF COMPUTER ENGINEERING

College of Electrical and Mechanical Engineering (CEME)

National University of Sciences and Technology (NUST)

1. Course Information	
Course Number and Title:	Adv. Digital System Design
Credits:	3
Instructor(s)-in-charge:	Dr. Sajid Gul Khawaja
Course type:	Lecture
Required or Elective:	Required
Degree and Semester	MS-2023, 1st
Month and Year	Fall 2023

2. Course Schedule	
Lecture:	3 hrs/week, Meets twice weekly
Discussion:	1 hr/discussion, multiple discussion sections offered per quarter
Outside study:	7 hrs/week
Office Hours :	5 hrs/week by instructor, 3 hrs/week by teaching assistant/lab engineer

3. Course Assessment		
Exam:	2 Sessional and 1 Final (tentative)	
Home work:	4-5 Assignments	
Design reports:	1 Design report based on Semester Project	
Quizzes:	5-6 Quizzes	
Grading:	Quizzes:	10%
	Assignments:	10%
	Mid Term Exam:	25-30%
	Final Exam:	40-50%
	Semester Project:	7-10%

4. Course book and Related Course Material	
Textbooks:	1. Introduction to Digital Systems Design by Giuliano Donzellini, Domenico Ponta, Luca Oneto, Davide Anguita, **2018** 2. Digital Design of Signal Processing Systems by Shoab A. Khan, John Wiley & Sons
Reference Books:	1. Introduction to Reconfigurable Computing by Christophe Bobda 2. Xilinx material: IDE, Vivado, Spartan based SDKs 3. VERILOG HDL-A guide to digital design and synthesis by Samir Palnitkar, Prentice Hall Publisher 4. Advanced Digital Design with VERILOG HDL by Michael D. Ciletti, Prentice Hall Publisher 5. Advanced Digital Design with VERILOG HDL by Michael D.

	Ciletti, Prentice Hall Publisher

5. Catalog Descriptions

The objective of this course is to make the students working as digital designers of a system to realize they act as an architect, who can invent interesting structures fulfilling functionality with creativity and effectiveness. The design needs to be flexible, scalable, reusable, and testable. The main focus of the course is teaching students all the interesting elements of digital system design and the cost of inclusion of these elements in terms of power and area on the systems.

6. Course Objectives

The objective of the course is to teach students.

a) VERILOG as hardware description language
b) FPGA architecture and logic Synthesis concept
c) Architecture of basic building blocks, adders, multipliers, shifters
d) Development of approximate units to build approximate systems.
e) Converting floating-point algorithms design in MATLAB to Fixed-point format
f) Effective HW mapping techniques: Fully parallel, Time-shared, micro-coded architectures, MPSoC
g) Designing State-machines based architecture
h) Design using ZYNQ SoC-H/W S/W Co-design using HLS

7. Topics covered in the Course and Level of Coverage

1. Reconfigurable Computing and FPGA architecture	3 hrs.
2. High-level digital design methodology using VERILOG, Design, Implementation, and Verification	6 hrs.
3. FPGA-based design and logic synthesis	2 hrs.
4. Application requiring HW implementation, Floating-Point to Fixed-Point Conversion	6 hrs.
5. Application to H/W Synthesis using KPN, and DFG mapping	4 hrs.
6. Transformation for high-speed using pipelining, retiming, and parallel processing (unfolding)	3 hrs.
7. Dedicated Fully Parallel Architecture, Time shared Architecture, Hardwired State Machine based	4 hrs.
8. Design State Machines and Custom Processor design using Micro Program State Machine	6 hrs.
9. Architectures for Basic Building Blocks, Adder, Compression Trees, and Multiplier	6 hrs.
10. Architectural Transformation using Multiplierless Multiplications, complexity reduction	3 hrs.
11. Advanced Topics: a. H/W S/W Co-design using ZYNQ SoC platform and HLS	6-9 hrs

b. Understanding Approximate Computing and Development of approximate units for approximate systems c. MPSoC Architectures	
12. Review: **Addressing student's queries before Midterm and Final Exam**	1-2 hrs.

8. **Mapping of Topics**	**Chapter(s)**	**Activities**
1. Reconfigurable Computing and FPGA architecture		
2. High-level digital design methodology using VERILOG, Design, Implementation, and Verification	Dr Shoab A. Khan: Chapter 2 **Introduction to Digital System Design:** Introduction to FPGA and HDL Design	**Design Activity Assignment after completion of topic**
3. FPGA-based design and logic synthesis	**Introduction to Digital System Design:** Introduction to FPGA and HDL Design "FPGA Two Day Beginners Workshop by Craig Kief et al."	**Coding Assignment after completion of topic**
4. Application requiring HW implementation, Floating-Point to Fixed-Point Conversion	Dr Shoab A. Khan: Chapter 3 **Introduction to Digital System Design:** Numeral Systems and Binary Arithmetic	
5. Application to H/W Synthesis using KPN, MPSoC and DFG mapping	Dr Shoab A. Khan: Chapter 4	**Group Design Problem Assignment after completion of topic**
6. Architectures for Basic Building Blocks, Adder, Compression Trees, and Multipliers	Dr Shoab A. Khan: Chapter 5	
7. Architectural Transformation using Multiplierless Multiplications, complexity reduction	Dr Shoab A. Khan: Chapter 6	
8. Transformation for high speed using pipelining, retiming, and parallel processing (unfolding)	Dr Shoab A. Khan: 1. Chapter 7 2. Chapter 8	
9. Dedicated Fully Parallel Architecture, Time shared Architecture, Hardwired State Machine based	Dr Shoab A. Khan: Chapter 9 **Introduction to Digital**	**Assignment after completion of topic**

	System Design: Sequential Networks as Finite State Machines	
10. Design State Machines and Custom Processor Design using Micro Program State Machine	Dr Shoab A. Khan: Chapter 10	
11. Advanced Topics: **a.** HLS based H/W S/W Co-design using ZYNQ SoC platform **b.** Approximate Computing	Internet Sources and Parallel Programming for FPGAs Internet Sources and Selected Papers for Approximate Units	**Assignment after completion of topic**