Bachelor of the Science of Engineering

Curriculum

Specialization in Computer Engineering

Faculty of Engineering

University of Jaffna

Sri Lanka

January 2020

CONTENTS

Computer Engineering Syllabi

Core Course Units

Semester 4

Course Unit	Code	Academic Credits	Lectures* (L)	Tutorial* (T)	Lab/ Field work* (L/ F)	Assign.* (A)
Digital Design	EC4010	03	29	N/A	18	30
Signals and Systems	EC4040	03	35	04	12	12
Electronic Circuits and Devices	EC4050	03	35	04	12	12

Computer and Data Networks
EC4060
03
28
08
15
24
Data Structures and Algorithms
EC4070
03
30
N/A
27
18
Discrete Mathematics
MC4010
03
31
28
N/A
N/A
* in hours

Code

EC4010

Title

Digital Design

Academic Credits

03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- design combinational logic circuits using Boolean optimization techniques;
- describe fundamental operations of sequential logic circuits and memory elements;
- demonstrate basic understanding of digital building blocks, such as ALUs, multiplexers,

encoders, priority encoders, and decoders;

- design synchronous and asynchronous sequential logic circuits;

- design digital systems using Hardware Descriptive Language;

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Introduction to digital logic

Digital signals, Digital Logic, Number Systems, Computers and Digital Systems, TTL/ CMOS, Purpose and role of digital logic in computer engineering, CMOS logic circuits

02

2. Combinational logic circuits

Boolean Algebra, Boolean laws and theorems, Sum-of products and Product-of-sums methods, Simplifications of Boolean expressions, Truth tables, Karnaugh Maps, Quine Mc-Clusky method, Don't care combinations, Elimination of timing Hazards, Introduction to HDLs

04

03

3. Sequential logic circuits and memory elements

SR flip flops, Gated, edge triggered and Master-slave operation, JK flip flop, D flip-flop, T flip-flop, Registers, Serial/Parallel conversion, Codes-Error detection and correction

06

03

03

4. Modular design of digital circuits

Introduction of Levels of Integration, Multiplexers, De multiplexers, Encoders, Decoders, read only memory (ROM), programmable logic arrays. Designing Arithmetic and Logic Unit (ALU), multipliers and dividers and building them using HDL.

06

03

03

5. Design of synchronous sequential circuits

06

03

Analysis of Synchronous circuits, Mealy and Moore Networks and Models, State diagrams and state tables, State minimization, State assignment, Assignment Rules, Next state and output equation realization, Design of Counters, ROM utilization for Sequential circuits.

06

6. Analysis and design of asynchronous sequential circuits

Analysis of Asynchronous circuits, Design Procedure, Flow tables, Reduction of state and flow tables, Race free State assignment, Hazards in asynchronous circuits

05

06

03

7. Digital circuit design and implementation

Solving a relatively complex problem via self-study and consolidating the knowledge acquired

15

29

18

30

Assessment/ Evaluation Details:

Textbooks and References:

– M. Morris Mano, and Michael D. Ciletti, Digital Design with an introduction to Veilog
HDL, VHDL, and System Verilog, 6th Edition, Pearson, 2017: ISBN-13: 978-0134549897.

– John F. Wakerly, Digital Design: Principles and Practices with Verilog, 5th Edition,
Pearson, 2017: ISBN-13: 978-0134460093.

– Wayne Wolf, FPGA-Based System Design, 1st Edition, Prentice Hall, 2004: ISBN-13: 978-0137033485.

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

15

Lab / Field Work

15

Mid Semester Assessment

20

End of Course Evaluation End Semester Examination

50

Code

EC4040

Title

Signals and Systems

Academic Credits 3

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- Explain differences between signals and systems and properties of LTI systems;
- Analyse continuous-time signals and systems in both time domain and frequency domain;
- Analyse resonant circuits and two port networks;
- Design analogue filters;

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Introduction to Signals and Systems

Introduction to Signals, Basic continuous time signals, Introduction to Systems, Types of Systems, properties of systems, Analyse linearity and time invariance

03

2. Representation of Linear Time invariant Systems

Representation of signals in-terms of impulses, Impulse Response, The convolution integral, Representation of LTI systems with differential equations and their zero-state and zero-input responses

04

3. Fourier Analysis of Continuous time Signals and Systems

Fourier Transform, Frequency representation of signals, Spectrum of signals, Properties of Fourier Transform, Application to Modulation.

05

01

04

4. Analysis of LTI System using Laplace transform

Analysis and characterization of LTI systems (RLC circuits, etc) using Laplace transform (zero-state, zero-input response, transfer function, Impulse and step responses), Pole-zero representations of Systems, BIBO stability of systems.

05

01

03

04

Note: Laplace transform and application to solve differential equation is already introduced through another subject MC3010

5. Frequency Response

Frequency response of Systems (RLC circuits, etc), Bode plots, realizations of systems.

05

03

6. Resonant Circuits

Series resonance, Resonance Frequency, Resonance Curves, Variation of current and voltage distribution in series RLC circuit with frequency, Selectivity, ‘Q’ factor, Half power frequencies, Bandwidth, Parallel resonance, Two branch parallel circuits, Resonance frequency, Q Factor, series to parallel conversion

04

02

03

7. Introduction to Two Port Networks

Impedance and Admittance, Hybrid parameters, inverse hybrid parameters, Transmission and Inverse Transmission parameters.

02

8. Analogue Filter Design

Analogue filters, types of analogue filters and properties, Basic filter design, Butterworth filter design, Low pass filter to high pass, band pass filter and band stop transformations, Realization of transfer function into opamp circuits.

07

03

04

35

04

12

12

Assessment/ Evaluation Details

References

1. Signals & Systems by Alan V. Oppenheim, Alan S.Willsky, S.HamidNawab
2. Signals and Systems by A. Anand Kumar

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

10

Lab Report / Field Report

20

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

50

Code

EC4050

Title

Electronic Circuits and Devices

Academic Credits 03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, the student should be able to

- Design advanced OP AMP, BJTs and FETs based analogy and digital circuits
- Design feedback based amplifiers, oscillators and waveform Generators
- Simulate Electrical and thermal Simulations of advanced circuits and PCB designs;

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Advanced BJT, FET Circuit Design

Use of BJTs and FEST in multi transistors amplifier design.

Cascade circuits, Cascode Circuits, differential pairs, current

mirrors, logic gates design, CMOS Designs, Class A, B, AB, C,

D, E, F, H, T operation (power amplifiers), Push-pull amplifiers

08

01

03

01

2. Advanced OP-AMP

Offset behaviour of op-amps (non-ideal behaviour), op-amp internal circuit, and Non-linear OPAMP circuits: Active diode circuits, comparators, complex op-amp circuits, and practical behaviour of op-amp (saturation, rise time), OP-AMP theory (Small signal and large frequency response, power bandwidth), offset voltages and offset currents, frequency responses.

05

01

3. Frequency Effects

Frequency response of an amplifier, Role of input and output coupling capacitors, High frequency bipolar analysis, Voltage gain outside the mid-band, Power and voltage gains, Rise-time bandwidth relationship, Stray effects, Identifying critical frequencies.

04

01

4. Feedback

Feedback theory, Negative feedback, negative feedback amplifiers

04

03

01

5. Oscillators

Theory of sinusoidal oscillation, The Wien bridge oscillator, RC oscillators, Colpitts oscillator, LC oscillator, positive feedback, multi vibrators, Schmitt trigger, waveform generator, 555 timer, Frequency Multipliers, Frequency Mixers, Modulators, VCO. Unwanted oscillation and ways to reduce it

06

03

01

6. Filter Design

Active Filters, 1st Order, 2nd Order, Higher orders,
implementing Butterworth, Chebyshev, Basil Thompson,
elliptic, 2nd orders with Sallen-key topology.

04

03

7. Circuit simulations and Printed circuit board fabrication

Device simulations by spice models and filter and multi stage
advanced electronic circuits electro thermal simulations,
multisim and proteus

04

03

8. Mini-Project

07

35

04

12

12

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

15

Lab / Field Work

20

Mid Semester Assessment

15

End of Course Evaluation

End Semester Examination

50

References:

1. Microelectronics circuits 6th edition – Sedra and Smith.
2. Microelectronics – Milmann and Grabel.
3. Opamps for everyone Mancini Ti/MIT 2002.

Code

EC4060

Title

Computer and Data Networks

Academic Credits

03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, the student should be able to

- explain the different types of computer networks and the concepts behind them;
- identify the different types of network topologies and protocols;
- describe different networking protocols at different levels of protocol stack and relevant standards that define such protocols;
- explain the functions of layers of the OSI model and TCP/IP;
- design a network based on given requirements specification.

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Principles of networking

Purpose and role of networks in computer engineering; Network architectures and protocols; Types of networks: LAN, WAN, MAN, and wireless, Contrasts between network architectures and protocols;

02

2. Networking models and protocols

Layered network architecture: OSI model, TCP/IP model, Hybrid models

02

3. Physical layer

Characteristics of media: Copper, Optical Fiber, wireless media, dialup networking, leased lines; Comparison of

media; Circuit switching Vs. Packet switching; ISDN; ATM;
ADSL; Delay models, FTTX
04
03
4. Data link layer
Services & Functions; connection-oriented and
connectionless services; Framing; Error Detection and
Control; Flow Control, PPP Protocol
04
02
03
5. Medium access sub-layer
Channel allocation: Aloha, Slotted Aloha, CSMA, CSMA/CD,
CSMA/CA , Ethernet; IEEE 802.3 Standards
04
02
03
03
6. Network layer
05
02
03
Services and Functions: connection-oriented and
connectionless
services, Routing, Distance vector and Link-state routing, IP
packet format, IP Classes, IPv4, IPv6, ICMP, ARP and
RARP protocols
7. Transport layer
Services & Functions: TCP and UDP protocols, TCP
message format, Congestion control, Sockets, flow control
04
02
03
8. Application layer
Introduction to services: email, DNS, HTTP, and Web

services related protocols

03

03

03

9. Independent learning and implementation assignment

Project: Design a network for given specific requirement

15

Total

28

08

15

24

References:

1. Computer Networking: A Top-Down Approach, 6th Edition, James F. Kurose, Keith W. Ross.
2. Computer Networks (5th Edition) 5th Edition, Andrew S. Tanenbaum, David J. Wetherall.

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

20

Lab / Field Work

10

Mid Semester

Assessment

20

End of Course

Evaluation

End Semester

Examination

50

Code

EC4070

Title

Data Structures and Algorithms

Academic Credits

03

Prerequisite/s

EC2010 (Computer Programming)

Intended Learning Outcomes

By the end of this course unit, the student should be able to

- compare performance of different algorithms using asymptotic analysis;
- describe algorithmic design paradigms such as divide and conquer, dynamic programming
and greedy paradigm;
- apply a suitable algorithmic design paradigm when an algorithmic design situation calls for
it;
- use data structures such as the graphs, trees etc. and related algorithms to model engineering problems

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Running time and time complexity

Complexity of simple algorithms (Linear search, bubble, insertion and selection sort),Time and space efficiency of algorithms, Calculating the running of non-recursive algorithms, Asymptotic bounds: big-oh, big-omega and theta

04

03

2. Divide and conquer

Binary search, quick and merge sort, Expressing running time using recurrences, and solving them

04

03

3. Linear abstract data types

Inductive definition of linked lists, Stack and queue ADTs, Array and linked-list based implementations, Heaps as priority queues and heap sort

04

03

4. Hashing and the set ADT

Hash functions and codes, Collision handling, The Set ADT, Implementing Sets using hash tables

03

03

5. Trees

Tree ADT, Linked implementation, Tree traversal orders, Binary Search Trees, Balanced BSTs

03

06

06

6. Graphs

04

03

06

Graph ADT and variants: directed, weighted etc., Adjacency matrix and list based implementation, Depth and breadth first traversal, Transitive closure

7. Greedy algorithms

Making locally optimal choices. Examples: coin change problem, Single-source shortest paths (Dijkstra's algorithm) and Minimum spanning tree (Kruskal's algorithm)

04

03

03

8. Dynamic programming

Solving sub problems and memorization.

Examples: job scheduling and Smith-Waterman sequence alignment

04

03

03

30

27

18

Assessment/ Evaluation Details:

Textbooks and References:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to algorithms", 3rd Edition, 2009

2. Robert Sedgewick and Kevin Wayne, "Algorithms", 4thEdition, 2011

3. R.Lafore, "Data Structures and algorithms in Java", 2nd Edition, 2002

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

10

Lab / Field Work

20

Mid Semester

Assessment

20

End of Course

Evaluation

End Semester

Examination

50

Code

MC4010

Title

Discrete Mathematics

Academic Credits 03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, the student should be able to

- identify fundamental mathematical concepts and terminology;
- analyse recursive definitions;
- describe different types of discrete structures;
- apply techniques for constructing mathematical proofs, illustrated by discrete

mathematics

examples

- identify basics of discrete probability and number theory
- apply the methods from discrete probability and number theory in problem solving.

Syllabus Outline

Content

Hours

L

T L/F A

1. Functions, relations and sets

Basic terminology, operations, practical examples, basic counting

principles, diagonalization and pigeonhole principle

07 04

2. Basic logic

Propositional and predicate logic

05 06

3. Proof techniques

Basic structures, recursion, structural induction

07 06

4. Basics of counting

permutations and combination, Master theorem, recurrence equations

07 06

5. Discrete Probability

Monte Carlo method, case analysis of algorithms, and hashing

05 06

31 28

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

10

Mid Semester Assessment

30

End of Course Evaluation

End Semester Examination

60

Semester 5

Course Unit

Code

Academic

Credits

Lectures*

(L)

Tutorial*

(T)

Lab/ Field

work* (L/ F)

Assign.*

(A)

Digital Signal Processing

EC5010

03

33

06

12

15

Analogue and Communication

EC5020

03

36

N02

09

15

Control Systems

EC5030

03

35

04

12
12
Database Systems
EC5070
03
31
08
18
12
Software Construction
EC5080
03
25
12
30
12
Computer Architecture and
Organization
EC5110
03
37
N/A
12
12
* in hours

Code

EC5010

Title

Digital Signal Processing

Academic Credits 03

Prerequisite/s

EC4040 (Signals and Systems)

Intended Learning Outcomes

By the end of this course unit, students should be able to

- Develop A/D or D/A conversion systems.
- Apply transformation of digital signals into frequency domain to analyse the signals;
- Apply time-frequency analysis for signal processing tasks;

- Design digital filters for a given specification or an application;
- Apply conversion of sampling frequency of a digital signal using multirate techniques;

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Digital Signals and Digital Systems

Digital signals, Sampling and reconstruction, Aliasing, Quantization, Reconstruction filter, Ideal D/A conversion, digital systems, classification of digital systems, LTI systems, impulse response and stability of LTI systems, FIR and IIR systems, convolution.

05

01

03

2. Z-Transform

Definition of z-transform, Properties of z-transform, inverse z transform, applications of z- transform to estimation of frequency response, pole-zero diagram, second order resonant systems

03

01

3. Digital Filters

Recursive and non-recursive filters, digital filter realizations, magnitude and phase response, all pass filters, oscillators, notch filters, second order resonance filter and stability

05

01

03

4. Discrete Fourier Transform and Discrete Time Fourier Transform

Discrete Fourier Transform and Discrete Time Fourier Transform, their inverse transforms, Parseval's theorem, effect of zero padding.

04

01

5. Digital Filter Design

Selection criteria of FIR and IIR, IIR filter design methods (bilinear, impulse invariant), digital to digital transforms, FIR filter design methods (windowing and frequency sampling)

07

01

03

6. Multi rate signal processing

Up sampling and down sampling. Time domain and frequency domain interpretation of up/down sampling, conversion by non integer factor. Modulation.

05

01

03

02

7. Introduction to time-frequency analysis

Short time Fourier transform and its application, introduction to wavelet transform.

04

8. Independent learning and implementation assignment

Small task on speech, image or biomedical signal processing

13

33

06

12

15

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

20

Lab Report / Field Report

15

Mid Semester Assessment

15

End of Course Evaluation

End Semester Examination

50

References

1. Signal Processing & Linear Systems B.P. Lathi, Zhi
2. Discrete-Time Signal Processing, Alan V. Oppenheim, Ronald W. Schafer
3. S. K. Mitra, Digital Signal Processing, McGraw-Hill, 2011
4. J. Proakis& D. Manolakis, Digital Signal Processing, Prentice-Hall, 2007

Code

EC5020

Title

Analogue and Digital Communications

Academic Credits 03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, the student should be able to

- Design analogue and digital modulation and demodulation techniques;
- Demonstrate the understanding in random signals and noise processes;
- Evaluate the effects of noise in received signals for different modulation schemes;
- Describe the basics of information theory;

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Analogue modulation and demodulation

AM (DSB, SSB, VSB), FM, PM and their frequency representations, demodulation schemes, Transmitters and receivers for analogue modulation, Super-heterodyne receiver, Analogue pulse modulation (PAM,PWM,PPM)

08

03

03

2. Principle of digital transmission of data

Digital Pulse Modulation (PCM, DM, DPCM), Multiplexing, Baseband Digital Transmission System, Line codes and Power Spectra, Inter Symbol Interference, Pulse Shaping (Nyquist Criterion), Equalization (Zero-Forcing), Baseband M-ary data, Eye diagrams, Digital Passband modulation techniques (BASK,PSK,FSK,QAM, binary and M-ary modulation schemes, Constellation diagrams)

11

03

06

3. Random process and noise

Random signals and process, thermal, white noise, filtered noise, noise equivalent bandwidth, correlation and covariance, PSD and wiener-Khinchin theorem, filtered noise, noise equivalent bandwidth, Strict sense stationary process, wide sense stationary process, ergodic process, Gaussian random process, Power spectral density, Input-output relationship.

06

02

4. Performance of analogue and digital communication under noise

Noise in Analogue Communication: Signal to Noise Ratio, Bandpass Receivers, Noise in Coherent Receivers, Noise in Incoherent Receivers, Noise in FM detection; Noise in Digital Communications: BER, Detection of Single Pulse in Noise, Optimum detection of Binary PAM, Optimum detection of BPSK, detection of QPSK and QAM in noise, Optimum detection of Binary FSK

09

03

06

5. Introduction to Information Theory

Channel Capacity, Binary Symmetric Channels, Introduction to

Source coding

02

36

02

09

15

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

10

Lab / Field Work

20

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

50

References:

1. **Introduction to Analog & Digital Communications** by Simon Haykin and Michael Moher, 2nd Edition,
John Wiley & Sons, Inc. 2007.

2. **Communication Systems Engineering** by John G. Proakis and Masoud Salehi, 2nd Edition, Prentice
Hall, 2001.

3. **Principles of Communications: Systems, Modulation and Noise**, Rodger E. Ziemer and William H.
Tranter, 7th Edition, Wiley & Sons, Inc. 2014.

Code

EC5030

Title

Control Systems

Academic Credits 03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, the student should be able to

- Demonstrate basics of a control system and its components;
- Demonstrate representation and analysis of different systems;
- Analyze properties of systems in time and frequency domain;
- Distinguish different control techniques used in real applications;
- Apply control system techniques in engineering applications;

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Introduction: The concept of a control system and its components

Introduction to feedback system, block diagrams and block diagram algebra, modelling physical systems, basic classification of control systems, open loop and closed loop systems, control design process and physical level concerns

05

02

03

2. Dynamic system representation

Linear system model in time domain, Nonlinear system models in time domain, State space model of dynamic systems, linearization of nonlinear state space model, models for linear time invariant systems

07

03

3. Analysis and properties of linear state space systems

State space equation in the time domain, State space equation in the Laplace domain, Transfer functions of differential operator SISO systems: poles and zeros, Stability of linear time invariant systems, observability of linear state space systems, Controllability of linear state space systems, Realisation of transfer functions

06

03

4. System stability analysis: Time and Frequency domain analysis

05

01

03

Stability (stability criteria in s-domain including Routh-Hurwitz criteria), Time domain analysis (1stand 2ndorder system), Frequency domain analysis (bode diagram, Nyquist diagram, phase and gain margin to improve stability, root-locus design), Nominal closed loop stability

5. Classic control techniques

Proportional controllers, Proportional-Integral controllers, Ideal and practical proportional-derivative controllers, Ideal and practical proportional-integral-derivative controllers, Lag compensation, Lead compensation, Lead-lag compensation

05

03

03

6. Modern digital control

Introduction to digital control: zero order hold sampling of transfer function and state-space system, Pole placement for SISO state space systems, Observer-based state feedback, Reduced order observers, Guidelines for picking the closed loop poles, Pole placement for MIMO systems – the linear quadratic regulator problem

04

01

03

7. Control system design and performance analysis

Designing control system for sampled systems, Robust stability for plant parameter variations, Disturbance rejection and noise attenuation, Design trade-offs, Output regulation

03

03

35

04

12

12

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

10

Lab / Field Work

20

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

50

References

1. Automatic control systems, Benjamin C. Kuo

2. Control systems Engineering, Norman S. Nise

Code

EC5070

Title

Database Systems

Academic Credits

03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- differentiate database systems from file systems by enumerating the features, functions
and benefits;
- explain and apply the fundamental concepts in data modeling, both at the conceptual and
logical level, with specific reference to the ER and relational models, respectively;
- Identify the Importance of relational database management and normalizations;
- apply the Query Languages for database definition and manipulation;
- identify the concept of database transaction

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Introduction to database systems Information models and Systems, Database system evolution, File based systems, DBMS approach, Database environment and components, DBMS functions, DBMS architecture, Data independence, Database system life cycle

03

2. Data modelling

Importance of data modelling in system development; Levels of abstraction and practice; Conceptual models: ER/EER and UML; Logical models: Relational and OO Models, Relational mapping

06

02

03

3. RDBMS concepts

Relational algebra and relational calculus; Relational integrity, Normalization: 1NF, 2NF, 3NF and BCNF; Object oriented extensions

06

02

4. Database query languages

4GL environments; SQL: DDL, DML and DCL; Triggers; Views

06

02

03

5. Database programming techniques

Embedded SQL; Database programming with

function/procedure calls: ODBC, JDBC; Stored procedures

04

02

03

6. Introduction to indexes and query optimization

Types of indexes: primary and secondary indexes, Query

optimization: rule based and cost based approaches

03

03

7. Introduction to transaction processing

Transactions, ACID properties, Concurrency control,

Serialization, Failure and recovery

02

8. Independent learning and implementation assignment Project

01

18

31

08

12

18

Assessment/ Evaluation Details:

Textbooks and References:

1. Ramez Elmasri and Shamkant B. Navathe, “Fundamentals of Database Systems”,

6th Edition, 2011.

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

15

Lab/Field Work

10

Mid Semester

Assessment

25

End of Course

Evaluation

End Semester

Assessment

50

Code

EC5080

Title

Software Construction

Academic Credits

03

Prerequisite/s

EC2010 (Computer Programming)

Intended Learning Outcomes

By the end of this course unit, the student should be able to

- use the advanced features of a selected programming language
- collect data with the consideration of efficiency
- apply suitable methods to input and output data with proper error handling mechanism and textual parsing formats
- apply declarative programming, object-oriented programming and event-driven programming techniques to solve problems
- develop applications with concurrency mechanisms and sockets
- improve code quality using code analysis and testing techniques

Syllabus Outline

Content

Hours
L
T
L/F
A

1. Introduction of features of a selected language

Control constructs, static / dynamic typing, scope and name spaces, automatic memory management

04

03

2. Data collections (containers)

Lists, tuples, sets and hash tables, Iterating over collections, efficiency considerations

02

02

03

03

3. Input/output, error handling and parsing textual formats

Command-line arguments, files and streams, errors and exceptions, pattern matching with regular expressions, parsing structured data (HTML, XML and JSON.)

03

02

06

03

4. Declarative programming

Functions as first-class values, closures, collection-oriented programming: map, filter and reduce (accumulate)

03

02

03

03

5. Classes and objects

Classes as user-defined types, object instances, references and aliasing, composing objects, defining linked structures (trees and graphs)

03

02

06

6. Event-driven programming

03

02

03

03

Graphical user interfaces and callbacks, Observer pattern and model-view separation, threading and asynchronous updates

7. Concurrency and network clients

Language facilities for concurrency (co-routines, fork/join), multiprocessing and pipelines, sockets

04

02

03

8. Code quality

Secure programming, assertions and unit tests, writing testable code, test and build automation, code modularity and reuse

03

03

25

12

30

12

Assessment/ Evaluation Details:

Textbooks and References:

1. Bertrand Meyer, "Object-Oriented Software Construction", 2nd Edition, 1997
2. Cay S. Horstmann, "Core Java Volume I--Fundamentals", 10th Edition, 2016

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

10

Lab / Field Work

20

Mid Semester

Assessment

20

End of Course

Evaluation

End Semester

Examination

50

Code

EC5110

Title

Computer Architecture and Organization

Academic Credits 03

Prerequisite/s

EC4010(Digital Design)

Intended Learning Outcomes

By the end of this course unit, students should be able to

- Describe the essential elements of a computer such as the microprocessor, memory hierarchy and interfaces and busses;
- Design single and multi-cycle processors;
- Explain the improvements of computer performance via pipelining and other processor architectures and memory hierarchies;
- Describe the current trends in processor industry including multiprocessor, multicore systems;
- Design architectural solutions using a Hardware Description Language.

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Overview
Introduction to computer architecture, the five classic components of a computer: input, output, memory, data path and control;Role of computer architecture in computer engineering.
01
2. Computer Abstractions and Technology
From high level language to the language of the hardware;Technologies and their trends for building memories and processors.
02
3. Instruction Set Architecture
Instructions as the language of computer, instructions as operators and operands, instruction formats and addressing modes;Instructions for arithmetic and logical operations and control flow.
03
06
02
4. CPU Organization
06
02
Implementation of the von neumann machine; control and data paths, single vs. multiple cycle datapaths; register transfer notation, conditional and unconditional transfers, ALU control; control unit: hardwired vs. micro-programmed realizations
5. Pipelining
Introduction to instruction level parallelism; Overview of pipelining: pipelined data paths and control;pipeline hazards: structural, data and control hazards, forwarding, stalls; reducing the effect of hazards.
04
02
6. Processor Design and Simulation
Use a hardware description language (HDL) to design,

implement and simulate processor elements.

02

06

7. Memory Hierarchies

Memory systems hierarchy, electronic, magnetic and optical technologies; main memory organization, latency, cycle-time, bandwidth and interleaving; cache memories: address mapping, line size, replacement and write-back policies, virtual memory, page faults, TLBs, protection.

06

02

8. Interfacing and Communication

I/O fundamentals: types and characteristics of I/O devices, handshaking, buffering; Buses: types of buses, synchronous and asynchronous buses, bus masters and slaves, bus arbitration, bus standards; programmed I/O, interrupt driven I/O, Interrupt structures: vectored and prioritized, interrupt overhead; direct memory access

05

02

9. Performance Issues

Defining and measuring performance: response time vs. throughput; metrics for computer performance, clock rate, MIPS, cycles per instruction, benchmarks, limitations of performance metrics;Amdhal's law.

05

02

10. Multiprocessors and Current Trends

Introduction to shared memory multiprocessors, clusters, message passing systems, Flynn's classification; current trends on processor architectures.

03

37

12

12

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

20

Quiz

10

Lab Report / Field Report

10

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

40

References:

1. David A. Patterson and John L. Hennessy, “Computer Organization and Design”, 5th Edition, 2014

2. John L. Hennessy and David A. Patterson, “Computer Architecture: A Quantitative Approach”, 6th Edition, 2017

Semester 6

Course Unit

Code

Academic

Credits

Lectures*

(L)

Tutorial*

(T)

Lab/ Field

work* (L/ F)

Assign.*

(A)

Embedded Systems Design

EC6020

03

34

N/A
12
21
Software Engineering
EC6060
03
30
04
12
27
Computer Engineering
Research Project I
EC6070
03
02
N/A
N/A
129
Operating Systems
EC6110
03
31
N/A
18
24
Robotics and Automation
EC6090
03
30
N/A
18
27
* in hours
Code
EC6020
Title
Embedded Systems Design
Academic Credits 03
Prerequisite/s
Computer Programming

Intended Learning Outcomes

By the end of this course, students should be able to

- explain embedded systems, in terms of both software and hardware;
- demonstrate in depth knowledge of embedded system design and design methodologies;
- demonstrate in depth understanding of core issues and aspects of interfacing embedded systems to different peripherals, different protocols to enable this interfacing and write software programs to interface with peripheral devices;
- demonstrate embedded real-time system operation and main components;
- explain networked embedded system requirements and constraints;
- design a microcontroller based system to satisfy given design specifications and document the design.

Syllabus Outline

Content

Hours

L

T

L/ F

A

9. Introduction to Embedded Systems

General introduction to embedded systems and applications; Design challenge – optimizing design metrics: unit cost/ NRE cost/ Size/ Performance/ Power/ Flexibility/ Maintainability/ Reliability; Differences between embedded systems and general purpose computing and processors.

02

10. Embedded Microcontrollers

Differences between microprocessors and microcontrollers; Programming a microcontroller: instruction sets, assembly language; Microcontroller Peripherals: timers/ counters/ UART/ PWM/ watch-dog Timer/ ADC; Introduction to microcontrollers: architecture and instruction set, I/O ports and peripherals; Introduction to programming environment and tools.

06

03

11. Interfacing and Mixed-Signal Systems

06

03

Microcontroller interfacing circuits: TTL/CMOS-voltage levels, controlling LEDs, 7-segment display, switch de-bouncing, keyboard scanning and LCD-display; interfaces and protocols for communications: timing diagrams, basic protocol concepts, SPI/I2C/UART; interrupts and interrupt service routines; peripheral to memory transfers: DMA; Analogue-to-Digital conversion techniques, Nyquist rate, quantisation errors; Arbitration techniques for multiple peripherals and single micro controller/processor.

12. Real-time Operating Systems

Role of an Embedded Operating System; Introduction to real time operating systems, tasks, threads, processes and scheduling. Memory management; Considerations when selecting an operating system for embedded applications.

04

03

03

13. Low-power Computing

Power consumption in VLSI circuits; Techniques for improving power consumption: parallelism, very long instruction word (VLIW), dynamic voltage scaling, dynamic power management.

02

14. Reliable System Design

Introduction to reliability, availability, maintainability, safety and security of embedded systems.

02

15. Design Methodologies

Aspects of embedded system design: Specification (functional requirements), Modelling, Architectures, HW/SW implementation, Prototype and validation; Verification and validation; HW/SW co-design methodologies.

03

16. Tool Support

Software environments for embedded systems.

03

03

17. Embedded Multiprocessors

Introduction to multiprocessor System-on-Chip (MPSoC) systems; task transaction level (TTL) interface for building parallel application models and implementing them on a multiprocessor platform.

03

18. Networked Embedded Systems

Introduction to networked embedded systems (NES); Functionality and constraints of NES; NES Examples: automobile, environment monitoring (data acquisition); Design considerations for NES: deployment, environment interaction,

03

03

life expectancy of nodes, wired/wireless communication protocol(s), re-configurability, security, operating system and energy constrain.

19. Design task

Microcontroller based embedded system design interfacing to a number of external peripherals (sensors and actuators).

15

34

12

21

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment/Project

30

Lab Report / Field Report

10

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

40

Code

EC6060

Title

Software Engineering

Academic Credits

03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- Explain on selecting process and methodology to a particular project;
- identify non-functional requirements and ensure a design meets them;
- develop use-cases to elucidate functional requirements ;
- design models in the unified modelling language using modelling tools;
- use OO language idioms and design patterns that enhances system modularity and maintainability;
- Design automate testing and refactoring into the project lifecycle;
- Implement a complete Software Engineering project

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Introduction

Goals of software engineering, challenges of large scale
software projects.

01

1. Lightweight Processes
Waterfall vs. agile development; Problems with the waterfall process; Agile release cycle: sprints and time boxing; Lightweight processes: lean, scrum and unified process; Adapting level of process formality
03
02
2. Requirements Specification System vision, business case and stakeholders; Writing functional requirements as use cases; Documenting nonfunctional requirements; Client sign-off and requirements traceability
03
01
2. Domain Modelling
Domain vs. implementation models; Basic UML diagram types and notation; Analysis patterns for constructing domain object models.
03
01
3. Implementation Transition Coupling and cohesion of components; System partitioning strategies: Responsibility-driven design, Domain driven design;
03
01
02
Modelling object interactions
with
sequence/collaboration diagrams or CRC cards.
3. Testing and Contracts
Specifying example behaviors with unit tests; Test frameworks and code coverage; Integration and regression tests for maintaining code quality; Design-by contract: pre and post conditions for methods, class invariants.

05
01
02
4. Principled Object-Orientation Interface vs. implementation; Object composition, aggregation and lifecycle; Value objects for immutability; Liskov substitution principle of inheritance; separating data, context and interaction (DCI), command/query separation (CQRS.) antipatterns and “code smells.”
04
02
4. Architectural Techniques Frameworks vs. libraries; Object assembly via dependency injection, Manual persistence vs. object-relational Mappers; Data binding; Cross-cutting concerns: logging, caching and security.
05
02
5. Software Reengineering Extracting design from legacy systems; Refactoring code safely; Tools for program comprehension and roundtrip engineering.
03
02
5. Software Engineering Project Following a complete software engineering process, from requirement gathering from a client/pseudo client to testing and deployment; Best software engineering practices should be followed in the project.
27
30
04
12
27

Assessment/ Evaluation Details:

Assessment Type
Assessment Method
Percentage

In-Course Assessment

Assignment (project milestones)

15

Quiz

10

Student Presentation (project)

10

Lab Report / Field Report

15

Mid Semester Assessment (Project)

10

End of Course Evaluation

End Semester Assessment

40

Code

EC6070

Title

Computer Engineering Research Project I

Academic Credits 03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- describe given research problem;
- identify gap and setbacks in existing researches;
- formulate research problem;
- review a research article critically;
- write a comprehensive research proposal;
- present comprehensive research proposal.

Syllabus Outline

Content

Hours

L

T

L/ F

A

6. Introduction

Research methodology; Review of research articles; Research proposal writing; Plagiarism; Literature review; Prepare preliminary report; How to select easy reading papers for start up?

02

7. Research Project

129

02

129

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Annotated Bibliography

15

Mid Semester Assessment

35

End of Course Evaluation

End Semester Examination

50

Code

EC6090

Title

Robotics and Automation

Academic Credits 03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- Analyse models for various types of robot arm manipulators within the calculated workspace;
- Explain fundamentals of machine vision and image processing techniques;

o Construct programs for robot control boards using various type of sensors and actuators
for localization and control of the robot;
o Create a simple to medium complexity PLC program.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Introduction to Autonomous Robots

Robotics in general, Modelling of robot joints, Forward kinematics, inverse kinematics workspace

03

2. Current and Future Trends in Robotics

Various types of robot arm manipulators, degrees of freedom, Visual based control, Image based visual servoing, position based visual servoing.

03

03

3. Motors and Motor Control Techniques

DC, Stepper and Servo, PWM, H-bridge.

02

03

4. Sensors and Actuators

IR, Switch and Sonar, Internal and external sensors and Sensor Fusion for robot control, Position Encoders, Force-Torque sensors, and Ultrasonic Sensors, Pneumatic and Hydraulic actuators.

03

5. Pneumatic and Hydraulic Control Systems

Air logic controls and control valves, pressure control valves, accumulators, etc. hydraulic and pneumatic circuits, parallel and series circuits, hydraulic vs. pneumatic

03
03
6. Machine Vision
Human vision vs machine vision, Image formation and acquisition, motion vision, image processing and filtering, object representation, application to robotics.
03
7. Autonomous Mobile Robots and Robot Intelligence
Issues in autonomous mobile robots such as self-localization and navigation. Sensor fusion, differential drive, sequential drive, tri-cycle.
04
8. Robot Control Board
Feedback controls for position and speed of robots. Programming of the robot control board from a PC, Integration of sensors and actuators to the robot control board.
04
06
9. Programmable Logic Controllers
Introduction to programmable controllers (PLC), PLC ladder logic programming, fundamental commands of PLC, introduction to relays and control, PLC hardware.
05
03
10. Robot Design Mini Project
Design projects and associated electronics and sensors to control them.
27
30
18
27
Assessment/ Evaluation Details
Reference:
1. Spong, Mark W., Seth Hutchinson, and MathukumalliVidyasagar. Robot modeling and
control. Vol. 3. New York: Wiley, 2006.

2. Siegwart, Roland, et al. Introduction to autonomous mobile robots. MIT press, 2011.

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

30

Lab Report / Field Report

20

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

30

Code

EC6110

Title

Operating Systems

Academic Credits

03

Prerequisite/s

EC4070 (Data Structures and Algorithms)

Intended Learning Outcomes

By the end of this course unit, students should be able to

- describe the functionalities and the applications of operating systems
- explain the problems associated with inter-processor communication (IPC) and various
solutions for them
- explain memory management techniques and virtual memory
- describe deadlocks and how to handle them
- describe various file and I/O systems and their functionalities
- discuss the design issues of modern operating systems

Syllabus Outline

Content

Hours

L
T
L/F
A

1. Introduction

The role and the purpose of an operating system (OS), history of OS, System calls

02
03
06

2. Process and threads

Processes, threads, different-levels of threads (user-level, kernel-level) and mapping between them, POSIX and other selected thread API, process state and transition diagram, context switching, multi-programming;

Inter-Processor Communication (IPC) – race condition, critical section, proposals for achieving mutual exclusion, atomic operations, semaphores, monitors;

Classical IPC problems - dining philosophers, sleeping barber and readers/writers;

Process scheduling, Deadlocks (detection, recovery, avoidance, prevention)

12
09
09

3. Memory Management

Swapping, contiguous memory allocation, paging and segmentation, structure of page table, virtual memory, page replacement algorithms.

06
03
03

4. File Systems

05
03

File organization and access methods, directories, file sharing,

record blocking, file system security, virtual file system,
implementation techniques and their trade-offs, UNIX access
control.

5. Input / Output

Device access, interrupt handling, device drivers, API for device
access, DMA, IO-MMUs, UNIX drivers, I/O buffering, Disk
structure and scheduling.

04

03

6. OS implementation methods

Design issues, kernel structuring methods, virtual machine
monitors, small kernels.

02

7. Self-study

Modern trends in OS design and implementation and their
industrial applications

03

31

18

24

Assessment/ Evaluation Details:

Textbooks and References:

1. Silberschatz, P. B. Galvin, and G. Gagne, "Operating System Concepts", 9th Edition,
2013
2. S. Tanenbaum and H. Bos, "Modern Operating Systems", 4th Edition, 2014
3. William Stallings, "Operating Systems: Internals and Design Principles", 8th Edition,
2014

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

15

Lab / Field Work

10

Mid Semester
Assessment
25
End of Course
Evaluation
End Semester
Examination
50

Semester 7

Course Unit
Code
Academic
Credits
Lectures*
(L)
Tutorial*
(T)
Lab/ Field
work* (L/ F)
Assign.*
(A)
Project Management and
Engineering Industry
ID7010
03
39
N/A
N/A
18
Computer and Network Security EC7020
03
32
04
18
15
Computer Engineering
Research Project II
EC7070
03

02

N/A

N/A

129

* in hours

Code

ID7010

Title

Project Management and Engineering Industry

Academic Credits 03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- discuss overview of engineering industry and its operations;
- describe methods and techniques of managing projects;
- discuss project control and monitoring;
- analyse a project in terms of finance;
- describe laws and ethical practices in engineering industries;
- organize a case study on project management.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Introduction - Course Overview

Introduction to engineering industry; Different engineering industries and respective functions of those industries; Current trends and issues in engineering industry.

02

2. Human Resource Management

Organization; Organizational behavior; Jobs; Roles; Employee resourcing; Performance management; Change management;

Leadership.

03

3. Process design, Facility Layout

A process view of a firm; Process structure; Product attributes; Process attribute; Product layout; Process layout; Layout design process.

03

4. Introduction to Project Management

Principles of project management; Classical theories of management; Planning and organizing.

01

5. Project Management, CPM, PERT

Definitions of projects; Examples; Importance of project management; Project life cycle; Network diagrams to represent

05

03

projects; Network planning models; Critical path method (CPM); Project evaluation and review technique (PERT), Scheduling tools (Ex: MS Project, Project Primevera); Risk analysis.

6. Project Management, Crashing, Cost Control

Methods and techniques of managing project completion time, crashing, cost estimation and control.

03

7. Contracts and Procurement

Types of contracts; Preparation of tender; Stages of tender submission; Process in bidding and awarding; Request for proposal (RFP); Request for qualification (RFQ); Request for bid (RFB); Request for information (RFI).

05

03

8. Industrial Law and Ethics

Labor law; Environmental health and occupation law; Company law; Copyright; Intellectual property and patent; Tax and revenue law; International treaties; CSR; IESL Code of Ethics.

08

06

9. Financial Accounting

Basic accounting concepts; Trial balance; Profit and loss account; Balance sheet; Cash flow statement.

03

03

10. Engineering Economics

01

11. Entrepreneurship and Marketing

Definition; Relevant economic, psychological and sociological theories of entrepreneurship; Characteristics and functions of an entrepreneur; Marketing environment; Product lifecycle; Consumer behavior; 4Ps.

02

12. New Business Start-up and Development

Registration procedure of new start-up; Patent procedure; Commercialization of mobile apps.

02

03

13. Guest Lecture by Industry Person

01

39

18

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

20

Mid Semester Assessment

30

End of Course Evaluation

End Semester Examination

50

Code

EC7020

Title

Computer and Network Security

Academic Credits

03

Prerequisite/s

EC4060 (Computer and Data Networks)

Intended Learning Outcomes

By the end of this course, students should be able to

- explain common barriers of network security and major issues involved in implementing
proper security measures;
- describe encryption techniques, and public, and private keys;
- compare different types of firewalls and configure them to eliminate security vulnerabilities;
- appraise vulnerabilities and risks of web and mobile applications;
- design measures to overcome the vulnerabilities and risks of web and mobile applications;

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Overview

Introduction to security properties, threat models, and
examples;

01

02

2. Basic Attack techniques and Defences

Control hijacking attacks: exploits and defences;
Dealing with legacy code: sandboxing and isolation;
Tools for writing robust application code; Tools for
writing secure application code; Principle of least
privilege, access control, and operating system security;

Exploitation techniques, and fuzzing;
07
03
06
3. Overview of Cryptography
Use of cryptography in computer security; Public-key
and symmetric encryption; Hash functions, MAC, and
signatures.
02
02
4. Web security
Basic web security model; web application security;
session management and user authentication; Content
08
06
03
Security Policies; Web workers, and extensions; HTTPS:
goals, and pitfalls
5. Network security
Security issues in internet protocols: TCP, DNS, and
routing; Network defense tools: firewalls, VPNs, Intrusion
Detection and filters; unwanted traffic: denial of service
attacks; Malware: computer viruses, spyware, and key
loggers.
08
06
06
6. Security of mobile platforms
Mobile platform security models: Android, and iOS;
Mobile threats and malware;
06
03
32
04
18

15

Assessment/ Evaluation Details:

Textbooks and References:

– Jonathan Katz, and Yehuda Lindell, Introduction to Modern Cryptography, 2nd Edition, 2014: ISBN-13: 978-1466570269.

– Mark Stamp, Information Security principles, and practice, 2nd Edition, Wiley, 2011: ISBN-13: 978-0470626399.

– Alfred J. Menezes, Paul C. van Oorschot, and Scott A. Vanstone, Handbook of Applied Cryptography, 1st Edition, CRC Press, 1996: ISBN-13: 978-0849385230.

Assessment Type	Assessment Method	Percentage
In-Course Assessment	Assignment	20
	Lab Report / Field Report	20
	Mid Semester Assessment	20
End of Course Evaluation	End Semester Examination	40

Code

EC7010

Title

Robotics and Automation

Academic Credits 03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- Analyse models for various types of robot arm manipulators within the calculated workspace;
- Explain fundamentals of machine vision and image processing techniques;
- Construct programs for robot control boards using various type of sensors and actuators

for localization and control of the robot;

- Create a simple to medium complexity PLC program.

Syllabus Outline

Content

Hours

L

T

L/ F

A

11. Introduction to Autonomous Robots

Robotics in general, Modelling of robot joints, Forward

kinematics, inverse kinematics workspace

03

12. Current and Future Trends in Robotics

Various types of robot arm manipulators, degrees of freedom,

Visual based control, Image based visual servoing, position

based visual servoing.

03

03

13. Motors and Motor Control Techniques

DC, Stepper and Servo, PWM, H-bridge.

02

03

14. Sensors and Actuators

IR, Switch and Sonar, Internal and external sensors and Sensor

Fusion for robot control, Position Encoders, Force-Torque

sensors, and Ultrasonic Sensors, Pneumatic and Hydraulic actuators.

03

15. Pneumatic and Hydraulic Control Systems

Air logic controls and control valves, pressure control valves, accumulators, etc. hydraulic and pneumatic circuits, parallel and series circuits, hydraulic vs. pneumatic

03

03

16. Machine Vision

Human vision vs machine vision, Image formation and acquisition, motion vision, image processing and filtering, object representation, application to robotics.

03

17. Autonomous Mobile Robots and Robot Intelligence

Issues in autonomous mobile robots such as self-localization and navigation. Sensor fusion, differential drive, sequential drive, tri-cycle.

04

18. Robot Control Board

Feedback controls for position and speed of robots. Programming of the robot control board from a PC, Integration of sensors and actuators to the robot control board.

04

06

19. Programmable Logic Controllers

Introduction to programmable controllers (PLC), PLC ladder logic programming, fundamental commands of PLC, introduction to relays and control, PLC hardware.

05

03

20. Robot Design Mini Project

Design projects and associated electronics and sensors to control them.

27

30

18

27

Assessment/ Evaluation Details

Reference:

1. Spong, Mark W., Seth Hutchinson, and MathukumalliVidyasagar. Robot modeling and control.
Vol. 3. New York: Wiley, 2006.
2. Siegwart, Roland, et al. Introduction to autonomous mobile robots. MIT press, 2011.

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

30

Lab Report / Field Report

20

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

30

Code

EC7070

Title

Computer Engineering Research Project II

Academic Credits 03

Prerequisite/s

EC6070 (Computer Engineering Research Project I)

Intended Learning Outcomes

By the end of this course unit, students should be able to

- present research progress;
- describe challenges and obstacles encountered and provided remedies;
- comprehend research project review and progress;
- review a research article critically;

o present final results for the research thesis as proposed in the research proposal.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Introduction

Thesis writing; Methods of analysis; Referencing; Presentation

skills; Critical analysis.

02

2. Research Project

129

02

129

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Mid Semester Assessment

40

End of Course Evaluation

End Semester Assessment

60

Semester 8

Course Unit

Code

Academic

Credits

Lectures*

(L)

Tutorial*

(T)

Lab/ Field

work* (L/ F)

Assign.*

(A)

Computer Engineering Design

Proficiency

EC8020

03

06

N/A

24

93

Computer Engineering

Research Project III

EC8070

03

02

N/A

N/A

129

* in hours

Code

EC8020

Title

Computer Engineering Design Proficiency

Academic Credits

03

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- explain tasks in Engineering product design practice, and product realization
- apply technical knowledge in carrying out computer engineering design tasks.
- organize design works independently and creatively in a computer engineering environment.
- identify design requirements, relevant concepts, and resources in order to successfully
reach the design goals.

- evaluate designs by building prototypes and testing;

Syllabus Outline

Content

Hours

L

T

L/F

A

1. **Review: Product design flow.**

User need assessment and product analysis;

Innovative design flow: needs identification, concept development, establish target specification, analyse competitive products, generate product concepts, select product concept;

02

2. Engineering Design

Descriptive, and Prescriptive models, Systematic design, creative design methods, Rational methods, Design Ethics;

02

3. Case studies

Design for manufacturing, Mechanical and material aspect in design, Electrical, Electronic and IT aspects in Design;

02

4. Design task in Electronics

Design and develop an electronic circuit that satisfies a given set of requirements. The design must satisfy all functional requirements and specified non-functional requirements;

06

17

5. Design task in machine learning / high performance computing system / data mining / artificial intelligence.

Design and develop a machine learning /high performance computing / data mining/ artificial intelligence system that satisfies a given set of requirements. The design must satisfy all functional requirements and specified non-functional requirements;

06

6. Design tasks of; (2 common and unique tasks will be provided from the following list.)

(1) Signal Processing:

Design and develop a signal processing system that satisfies a given set of requirements. The design must satisfy all functional requirements and specified non-functional requirements;

(2) Digital System Design:

Design and develop a digital system using HDL that satisfies a given set of requirements. The design must satisfy all functional requirements and specified non-functional requirements;

(3) Embedded design:

Design and develop an embedded system, that to satisfies a given set of requirements. The design must satisfy all functional requirements and specified non-functional requirements;

(4) Control Systems:

Design and develop control system with data acquisition that satisfies a given set of requirements. The design must satisfy all functional requirements and specified non-functional requirements;

(5) Robotics and Automation:

Design and develop a robotic-automation system using suitable robotic development platform that satisfies a given set of requirements. The design must satisfy all functional requirements and specified non functional requirements;

12

47

06

24

93

Assessment / Evaluation method:

Textbooks and References:

– Nigel Cross, Engineering Design Methods strategies for product design, 4th Edition, Wiley, 2008: ISBN-13: 978-0470519264.

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Design / Lab Report /

Field Report

100

Code

EC8070

Title

Computer Engineering Research Project III

Academic Credits 03

Prerequisite/s

EC 7070 (Computer Engineering Research Project II)

Intended Learning Outcomes

By the end of this course unit, students should be able to

- present a research thesis;
- present at least one technical paper;
- present a business model.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Introduction

Research grant proposal writing; Possible research grants;

Effective presentation; Journal or conference paper writing.

02

2. Research Project

129

02

129

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Mid Semester Assessment

40

End of Course Evaluation

End Semester Assessment

60

Technical Elective Course Units

Course Unit	Code	Academic Credits	Lectures* (L)	Tutorial* (T)	Lab/ Field work* (L/ F)	Assign.* (A)
Advanced Digital Design and Synthesis	EC9040	02	25	N/A	06	09
Advanced Computer Architecture	EC9500	02	21	06	N/A	18
High Performance Computing Systems	EC9510	02	19			

N/A
18
15
Advanced Computer and Data
Networks
EC9520
02
24
N/A
09
09
Compiler Construction
EC9530
02
21
06
N/A
18
Human Computer Interaction
EC9540
02
24
N/A
13
05
Intelligent Systems Design
EC9550
02
21
N/A
15
12
Data Mining
EC9560
02
21
N/A
12
15
Digital Image Processing
EC9570
02
22
N/A

12
12
Computer Vision
EC9580
02
22
N/A
09
15
Network Application Design
EC9590
02
18
N/A
21
15
Applied Algorithms
EC9600
02
23
N/A
N/A
21
Communication Network Design for
Computer Engineering
EC9610
02
19
04
12
15
Wireless and Mobile
Communications for Computer
Engineering
EC9620
02
26
N/A
03
09
Machine Learning
EC9630
02
20

06
15
06
Artificial Intelligence
EC9640
02
20
04
06
18
* in hours
Code
EC9040
Title
Advanced Digital Design and Synthesis
Academic Credits 02
Prerequisite/s
EC6050 (Computer Architecture and Organization), EC4010 (Digital Design)
Intended Learning Outcomes
By the end of this course unit, students should be able to
- describe the fundamentals of sequential and combinational logic designs;
- apply concepts in designing the circuits;
- explain the concept of RTL and apply them in digital system design;
- differentiate various types of memory design and their applications;
- design a mini project using FPGA and suitable synthesizing IDE.

Syllabus Outline
Content
Hours
L
T
L/ F
A
1. Review
Basic logic design, number system and logic families.
01
2. Hardware Descriptive Language

Introduction to Verilog/ VHDL and design tools, behavioral synthesis of digital systems, Introduction to RTL based design, simulation and verification, PCB prototyping.

05

03

03

3. Design, Synthesis and Verification Tools

Layout editor, p-cells, cell libraries, P&R, VHDL compilers, process scaling, spice simulator, extraction, LVS.

02

4. Design of Combinational Logic

Introduction to programmable logic devices, Implementing combinational circuits using PLDs.

04

03

5. Design and Optimization of Sequential Circuit

State machines, transmission gates, transistor sizing, set-up and hold times, dynamic registers.

04

03

6. Processor Design

Instruction set architecture, hardwired and microprogramming approaches to processor design.

03

7. Memory Design

RAM, ROM, EPROM, SRAM, DRAM, memory cells and memory organization, cache memory design, memory interfacing.

03

03

8. Complex Digital Systems

System specification, design, implementation and performance evaluation on reconfigurable hardware (FPGA).

03

25

06

09

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

20

Lab Report / Field Report

20

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

40

Code

EC9500

Title

Advanced Computer Architecture

Academic Credits 02

Prerequisite/s

EC5110 (Computer Architecture and Organization)

Intended Learning Outcomes

By the end of this course, students should be able to

- define design decision about cache for performance;
- explainthe use of Instruction Level Parallelism (ILP) in improving computing performance
and its limitations;
- comprehend the use of Data Level Parallelism (DLP) in improving computing performance;
- make design decisions on using ILP and DLP for improving performance;
- explain the dependability issues in computer architecture;
- design a special purpose processor using HDL.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Fundamentals of Computer Design

Technology, cost and price and their trends; Measuring and reporting performance; Quantitative principles of computer design; Instruction set architecture and principles; Memory addressing and addressing modes.

02

2. Memory Hierarchy Design

Review of caches; Improving performance of caches: Reducing miss penalty/rates and hit time; Reducing cache miss penalty and miss rate via parallelism; Virtual memory protection; Shared-memory architectures: symmetric and distributed; Performance of shared-memory architectures.

05

02

3. Instruction Level Parallelism and its Exploitation

Instruction-Level Parallelism: concepts and challenges; basic compiler techniques for exposing ILP; Reducing Branch costs with advanced branch prediction; Overcoming data hazards with dynamic scheduling; dynamic scheduling: examples and

05

02

the algorithm; hardware-based speculation; Exploiting ILP using multiple issue and static scheduling; Exploiting ILP using dynamic scheduling, multiple issue, and speculation; cross cutting issues: ILP approaches and the memory system; Multithreading: exploiting thread-level parallelism to improve uniprocessor throughput.

4. Data-Level Parallelism in Vector, SIMD, and GPU Architectures

Vector architecture; SIMD instruction set extensions for multimedia; Graphics processing units; Detecting and enhancing loop-level parallelism.

03

08

5. Computer Architecture and Dependability

Reliability, availability and dependability issues in computer systems; Special hardware features to enable reliability and security of microprocessors.

03

02

6. Special Purpose Processors

Low power design methodologies; Processor customization based on applications: application specific integrated circuits (ASIC), application specific processors and field programmable gate arrays (FPGA).

03

10

21

06

18

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment (Project)

30

Quiz/Tutorial

10

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

40

Code

EC9510

Title

High Performance Computing Systems

Academic Credits 02

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course, students should be able to:

- define high performance computing;
- differentiate parallel and serial computing;
- identify decomposition and mapping methods in parallel algorithm design;
- perform interconnection network design, load balancing and communication costing;
- demonstrate parallel speedup and efficiency;
- define clusters and grids and their connectivity.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Introduction

Serial computing and limitations, computational demand, Flynn taxonomy, applications.

02

2. Parallel Algorithm Design

Granularity, foster methodology, interdependencies.

02

03

03

3. Interconnection Network and Communication

Interconnection topologies, communication methods, cost analysis.

03

4. Performance Analysis and Modeling

Performance matrices, speed up, efficiency, throughput, scalability.

03

03

03

5. Memory Management

Distributed, shared memory, uniform and non-uniform memory access, cache.

03

6. GPU Computing

Single instruction multiple data (SIMD) architecture, general purpose graphics processing unit (GPGPU) computing, heterogeneous computing.

02

06

03

7. Cluster Computing

Dependable cluster computing, high speed networks, lightweight message passing, load balancing over network, introduction to grid.

02

03

03

8. Distributed Architecture

Heterogeneous computing, remote procedure call, middleware architecture.

02

03

03

19

18

15

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

20

Quiz

10

Lab Report / Field Report

10

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

40

Code

EC9520

Title

Advanced Computer and Data Networks

Academic Credits

02

Prerequisite/s

EC4060 (Computer and Data Networks)

Intended Learning Outcomes

By the end of this course, students should be able to

- explain different internet architectures;
- demonstrate congestion control techniques of a network;
- analyse performance and quality of service of a network;
- explain different types of network, application layer protocols and web caching;
- explain mobile, wireless, and software defined networks;
- criticize network orchestration, and virtualization techniques;

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Internet Architecture and Design
Ethernet, Wi-Fi, cellular networks, internet of thing, cloud computing.
02
2. Network Measurement and Modeling
Active measurement, passive measurement, latency, packet loss, throughput, link utilization, introduction to network performance measuring tools, traffic modeling, single link analysis, multi - link analysis.
03
03
3. Congestion Control
Effects of congestion, traffic-aware routing, admission control, traffic throttling, load shedding, desirable bandwidth allocation, regulating the sending rate.
03
03
4. Quality of Service
Application requirements, traffic shaping, packet scheduling, admission control, integrated services, differentiated services, protocols for QoS.
02
5. Multicast Routing
02
Multicast routing in the internet, multicast routing protocols
6. Web Protocols and Web Caching
HTTPS, Introduction to web caching, kinds of web caching, how to control caches.
02
03
7. Mobile and Wireless Networking
Wireless links and network characteristics, WiFi, cellular internet access, mobility management principles, mobile ip, managing mobility in cellular networks, wireless and mobility.
03

03

8. Peer-to-Peer Networks

Overview of P2P, P2P topologies.

01

9. Software Defined Networking and Network Functional Virtualization

SDN architecture, characteristic of SDN architecture, SDN data plane functions and protocols, SDN control plane architecture, SDN application plane architecture, Orchestration, and Network Functional Virtualization

03

03

10. Multimedia over IP networks.

VoIP, H323, RTP/RTCP, and SIP

03

03

24

09

09

Assessment/ Evaluation Details:

Textbooks and References:

– Larry L. Peterson, and Bruce S. Davie, Computer Networks, 5th Edition, Morgan Kaufmann,
2011: ISBN-13: 978-0123850591.

– Tanenbaum, and Wetherall, Computer Networks, 5th Edition, Prentice Hall, 2010: ISBN-13:
978-9332518742.

– Kurose, and Ross, Computer Networking a top down approach, 7th Edition, Pearson, 2016:
ISBN-13: 978-0133594140.

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

20

Lab Report / Field Report

20

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

40

Code

EC9530

Title

Compiler Construction

Academic Credits 02

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course, students should be able to

- explain the issues that arise in program translation including syntax analysis,
translation,
and rudimentary program optimization;
- create and manipulate abstract program representations.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Overview

Compiler structure; Overview of translation: the frontend, the
optimizer, the backend.

01

2. Scanning

Recognizing words: A formalism for recognizers, recognizing
complex words; Regular expressions (RE): formalizing the
notation and examples, closure properties of Res; From regular
expression to scanners; Implementing scanners.

03
02
02
3. Parsing
Expressing syntax: why not REs, context-free grammars; top down parsing: transforming a grammar for top-down parsing, top-down recursive-descent parsers, table-driven LL (1) parsers; Bottom-up parsing: the LR (1) parsing algorithm, building LR (1) tables.
04
02
03
4. Context Sensitive Analysis
Type systems: the purpose and the components; Attribute grammar framework: evaluation methods, circularity, problems with attribute-grammar approach, Ad-hoc syntax-directed translation.
01
02
02
5. Intermediate Representations
Graphical IRs: syntax related trees, graphs; Linear IRs: stack machine, three-address code; Mapping values to names; Symbol table.
01
02
6. Inner Workings of a Compiled Code
The procedure abstraction: procedure calls, name spaces, communicating values between procedures, standardized linkages; Code shapes: assigning storage locations, arithmetic operators, Boolean and relational operators, storing and accessing arrays, character strings, structure references, control-flow, procedure calls.
02
7. Introduction to Compiler Optimizations

Considerations and opportunities for optimizations; Scope of optimizations; Local, regional and global optimizations; Inter procedural optimizations.

02

8. Code Selection

Code Generation; Extending the simple tree-walk scheme; Instruction selection via tree-pattern matching; Instruction selection via peephole optimization.

03

03

9. Instruction Scheduling

The instruction-scheduling problem; Local list scheduling and regional scheduling

02

03

10. Register Allocation

Local vs. Global register allocation and assignment.

02

03

21

06

18

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment (Project)

30

Quiz

10

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

Code

EC9540

Title

Human Computer Interaction

Academic Credits 02

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course, students should be able to

- explain the concepts of cognitive science and the physiology of human perception;
- identify the role of interaction and user experience design;
- analyse the need of user of an interactive system;
- apply the hci standards for interactive systems;
- apply the principles of sustainable hci design;
- analyse different options to recommend interactive design.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Introduction

HCI concepts.

01

2. Human Perception

Colour, graphic design, visualization, user mindset observation,

Cognitive aspects.

03

3. Ergonomics

Physical, cognitive, social, environmental factors.

03

4. Interface Design

Forms, interface design pattern, development tools, event

handling, responsiveness, small screen interfaces, design guidelines, prototyping.

06

06

5. Usability and Accessibility analysis

Content analysis, navigation, error handling, error prevention,

usability standards, internationalization, evaluation and testing.

05

04

05

6. Human Body and Device Design

Augmented computing, virtual reality.

03

03

7. Emerging technologies and their specific usability issues

Mobile technologies, e-commerce systems, multimedia,

entertainment and games, virtual and mixed-reality

environments, it security and security systems.

03

24

13

05

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

10

Quiz

10

Student Presentation

10

Lab Report / Field Report

10

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

40

Code

EC9550

Title

Intelligent Systems Design

Academic Credits 02

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course, students should be able to

- define the fundamental principles of intelligent systems;
- apply the problem solving techniques for intelligent systems;
- explain the knowledge representation and logical arguments;
- apply knowledge base system concepts make intelligent decisions;
- describe the machine learning and pattern recognition techniques;
- identify fuzzy sets and relations to model intelligent systems;
- apply fuzzy logic in the area of control.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Introduction

Fundamentals of artificial intelligence.

01

2. Searching

A* Search, breadth first search, depth first search, heuristic
search, tree search, optimization.

02

03

03

3. Knowledge Based System

Prepositional and predicate logic, proving, semantic web, knowledge base, inference engine, rule based expert system.

07

03

03

4. Fuzzy Logic

Classical and fuzzy set, fuzzy relation, membership function, fuzzy integral, fuzzy measures, defuzzification.

05

03

03

5. Machine Learning

Supervised learning, unsupervised learning, reinforcement learning, classification techniques, clustering, single layer and multi-layer perception, self-organizing map, deep learning.

06

06

03

Total

21

15

12

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

20

Quiz

10

Lab Report / Field Report

10

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

40

Code

EC9560

Title

Data Mining

Academic Credits

02

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- explain the fundamentals of data mining;
- apply pre-process technique to a dataset for further analysis;
- Use suitable machine learning algorithms for different data mining tasks
- develop data mining systems to solve problems.

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Introduction

Why, how, basic concepts, examples.

01

2. Data representation and pre-processing

Data cleaning, data transformation, feature selection and dimensionality reduction, discretization and generating concept hierarchies.

04

3. Experimental setup and evaluation

Training, testing, Cross-validation and parameter

selections, Evaluation measures (Confusion matrices,
Accuracy, Sum of squared errors)

01

4. Predictive analytics

Statistical classification, Bayesian networks, regression,
collaborative filtering, neural nets, decision trees,
nearest neighbours

08

03

5. Structural relationships in data

Frequent items, Association rules

02

03

6. Clustering

k-means, expectation maximization, agglomerative and
divisible clustering, conceptual clustering, , result
interpretation.

04

06

7. Applications

Text mining, web data analytics, social network
analytics.

01

15

21

12

15

Assessment/ Evaluation Details:

Textbooks and References:

– Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, The Morgan Kaufmann Series in Data Management Systems, ISBN-13: 978-9380931913,

– Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction to Data Mining,
1st Edition, Pearson, ISBN-13: 978-0321321367.

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

30

Lab Report / Field Report

10

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

40

Code

EC9570

Title

Digital Image Processing

Academic Credits

02

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- explain fundamentals of digital image processing;
- apply spatial, and frequency domain image filtering techniques;
- apply image enhancement, segmentation, and morphological operations;
- apply image compression techniques;
- describe fundamentals of medical image processing;
- explain image registration and matching techniques;

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Introduction

Imaging Modalities, digital images, pixels and voxels, colour components and colour spaces, monochromic, colour, and binary images, image processing applications.

02

1. Point Operations

Quantization, Grey values and brightness, Weber's law, Gama characteristics, adjusting brightness and contrast, image histogram (equalization and matching).

03

01

2. 2D Transforms

Fourier frequency domain, frequency domain techniques (filtering, image enhancement, and line and edge detection), discrete cosine transform, Karhunen - loeve transform, singular value decomposition.

03

02

3. Image Segmentation

Edge detection, grey-level thresholding, Otsu's method, locally adaptive thresholding, colour based segmentation, live-wire, water-shed, region growing, split and merge algorithm.

04

03

4. Morphological Image Processing

03

03

Morphological operations for grey - level images
(erosion, dilation, opening, and closing), Morphological
edge detector, Region filling, Rank filters, median
filters, Morphological Image processing applications.

5. Image Compression

Fundamentals, data redundancies, compression
models, error-free compression, lossy compression,
compression standards.

03

03

7. Fundamentals of Medical Image processing.

Imaging, Modalities, structural and functional imaging,
Computed Tomography(Basic principles, and
Sonogram), and Magnetic Resonance Imaging (Nuclear
Magnetic Response, Spatial Encoding, and image
quality);

02

8. Image Registration and Matching

Affine transformation, Smooth and Realign, Template
matching, Eigen face, fisher face

02

9. Independent Learning Task

12

22

12

12

Assessment/ Evaluation Details:

Textbooks and References:

– Rafael C. Gonzalez, and Richard E. Woods, Digital Image Processing, 4th Edition, Pearson,
2017: ISBN-13: 978-0133356724.

– Milan Sonka, Vaclav Hlavac, and Roger Boyle, Image processing Analysis, and Machine Vision,
4th Edition, CL Engineering, 2014: ISBN-13: 978-1133593607.

– William K. Pratt, Digital Image Processing, 4th Edition, Wiley-Interscience, 2007: ISBN-13: 978-
0471767770.

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

15

Lab / Field Work

15

Mid Semester Assessment

20

End of Course Evaluation End Semester Examination

50

Code

EC9580

Title

Computer Vision

Academic Credits

02

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course, students should be able to

- Explain the fundamentals of computer vision.
- Summarize the fundamental issues when extracting information from digital imagery
- Explain the fundamentals of image formation and representation.
- Explain digital cameras and sensors used to capture the image.
- Apply the computer vision tools and techniques.
- Develop computer vision solutions for real problem.

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Introduction to Computer Vision

Digital image, Computer vision examples

01

2. Image Formation and Representation

Camera, Image sensors , Camera Calibration

02

3. Depth Estimation

Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification

03

03

4. Features and Filters

Scale-invariant feature (SIFT), Histogram of oriented gradients (HOG), 2D- Discrete cosine transform (2D-DCT), Gabor Filters, Linear filters, Texture analysis

03

03

5. Feature-based alignment

2D and 3D feature-based alignment, Pose estimation

03

03

6. Object Detection and Classification

Bag of Words, Face detection, Face recognition, Pattern analysis

05

15

7. Video Processing

Tracking, Action recognition, Optical Flow, Kanade–Lucas–Tomasi (KLT), Spatio-Temporal Analysis

05

Total

22

9

15

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

20

Lab Report / Field Report

10

Mid Semester Assessment

20

End of Course

Evaluation

End Semester Examination

50

Code

EC9590

Title

Network Application Design

Academic Credits

02

Prerequisite/s

EC5080 (Software Construction)

Intended Learning Outcomes

By the end of this course, students should be able to

- demonstrate protocols as state machines;
- design a network server using request-response and remote procedure call styles from a
state machine;
- choose an appropriate technique for handling concurrent requests in servers;
- explain the trade-offs between rpc vs. request-response styles of protocol implementation;
- generate dynamic responses to http requests;
- develop session management and authentication in a web application.

Syllabus Outline
Content
Hours
L
T
L/F
A
1. Internet Protocol Stack
Connection-oriented vs. connection-less services, sockets, ports, addressing and name resolution.
02
02
2. Network Servers
Listening for and accepting connections, implementing a request-response protocol.
02
02
3. Design of Application Protocols
State-full vs. stateless protocols, representing protocols as state machines, keeping state, idempotence.
02
02
02
4. I/O Concurrency
Handling concurrent requests, multiprocessing, multithreading, asynchronous I/O.
02
03
02
5. Remote Procedure Calls
The RPC abstraction, web services (JSON-RPC and SOAP).
02
03
02
6. Dynamic Web Content Generation
Serving static and dynamic content, mapping URLs to handlers, processing form data, session management with

cookies.

02

03

03

7. Web Frameworks

Model-view separation, user interfaces generation with

templates, content management systems.

03

03

03

7. Network Application Security

HTTP-BASIC authentication, HTTP over SSL, validating

and sanitising inputs, common pitfalls.

03

03

03

18

21

15

Textbooks and References:

2. John Goerzen and Brandon Rhodes, "Foundations of Python Network

Programming", 3rd

Edition, 2014

3. Jan Newmarch, "Network programming with Go", 1st Edition, 2017

4. Elliotte Rusty Harold, "Java Network Programming", 4th Edition, 2013

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment (Project)

20

Lab Report / Field

Report

20

Mid Semester

Assessment

20

End of Course

Evaluation

End Semester

Examination

40

Code

EC9600

Title

Applied Algorithms

Academic Credits 02

Prerequisite/s

EC4070 (Data Structures and Algorithms)

Intended Learning Outcomes

By the end of this course, students should be able to

- describe real world applications of algorithms;
- utilize combinatorial algorithms for solution space search;
- perform exploratory analysis on huge and rapidly changing data;
- explain game theory as a mechanisms to achieve efficient and desirable global outcomes
in spite of the selfish behaviour;
- comprehend the use and the differences between localized algorithms as opposed to
centralized algorithms.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Overview

Revision on algorithms and their time and space complexities;

Examples of applications of algorithms in real world.

03

2. Combinatorial Algorithms and Graph Theory

Generating all and random instances of a combinatorial object in molecular; Exhaustive search through the solution space, which are represented as combinatorial structures such as permutations, combinations, set partitions, integer partitions, and trees; Graph theoretic models in molecular biology: RNA, proteins, and other structures described as graphs,

04

03

3. Bioinformatics Algorithms

Methods for the analysis of gene expression data.

04

06

4. Processing Data Streams

Exploratory analyses of huge and rapidly changing data streams such as network traffic, online auctions, transaction logs, telephone call records, automated bank machine operations, and atmospheric and astronomical events.

04

06

5. Game Theory

Game theory and applications; Nash equilibrium; algorithmic solutions and advances achieved through game theory

04

03

6. Localized Algorithms

Topology control for wireless ad-hoc or sensor networks; Neighbour elimination schemes, which remove edges from the initial connection graph in order to generate energy efficient, sparse, planar but still connected network in localized manner.

04

03

23

21

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

20

Quiz

20

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

40

Code

EC9610

Title

Communication Network Design for Computer Engineering

Academic Credits 02

Prerequisite/s

EC3010 (Electronics and Telecommunication), EC5020 (Analogue and Communication)

Intended Learning Outcomes

By the end of this course unit, students should be able to

- explain the basic concepts of signal propagation;
- apply suitable channel model for various wireless communication systems;
- describe at a system level on how communication networks work;
- explain the state-of-art technologies used in practical wireless communication systems
and networking;
- simulate simple communication systems using software (if there are any homework
assignments on MATLAB);
- demonstrate the ability to configure data network elements.

Syllabus Outline

Content
Hours
L
T
L/ F
A
1. Signal Propagation
Guided and un-guided propagation methods, reflection, refraction, diffraction & absorption effects, transmission lines, twin lines and the coaxial lines
03
01
03
03
2. Wireless Access Networks
Wi-Fi, cellular networks, DVB-H, satellite communications
02
3. Wireless Access
Base and subscriber stations, frequency planning, multiple access technologies, noise and interference mitigations in wireless communication systems, diversity techniques
03
02
03
4. Radio Frequency Network Design
Path delay profile, free space loss, link budget, fade margin and link availability, cellular structure, frequency reuse and planning
03
01
03
03
5. Core Networks
Optical fiber communication, optical fiber network design
03
03

6. Data Transmission Technologies

X.25, frame relay, asynchronous transfer mode (ATM), congestion control in data transmission, ip based networks, transmission in wans.

05

7. Data Network simulations using equipment

Configuring routers, GSateways

03

03

8. Case study: Design aspects of state of the art wireless technology (ex: 4G/LTE Technology)

03

19

04

12

15

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

30

Lab Report / Field Report

20

Mid Semester Assessment

20

End of Course Evaluation

End Semester Examination

30

Code

EC9620

Title

Wireless and Mobile Communications for Computer Engineering

Academic Credits 02

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be able to

- explain the basics of propagation of radio signals;
- explain how radio signals can be used to carry digital information in a spectrally efficient manner;
- illustrate insights into how diversity afforded by radio propagation can be exploited to improve performance;
- demonstrate spread-spectrum modulation;
- explain the design considerations for how to effectively share spectrum through multiple access.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Introduction

Overview of wireless communications

02

2. Wireless Channel Models

Path Loss and shadowing models, statistical fading models,

narrowband fading, wideband fading.

07

03

3. Flat-Fading Countermeasures

Diversity, adaptive modulation, multiple-input-multiple-output

(MIMO) systems

07

03

03

4. Multiuser Systems

Multiple access and networking

04

03

5. Cellular System Design and Capacity Analysis

Cellular concept, frequency re-use, channel assignment

strategies, capacity and cell coverage

06

26

03

09

Assessment/ Evaluation Details

Assessment Type

Assessment Method

Percentage

In-Course Assessment

Assignment

10

Lab Report / Field Report

15

Mid Semester Assessment

25

End of Course Evaluation

End Semester Examination

50

Code

EC9630

Title

Machine Learning

Academic Credits 02

Prerequisite/s

None

Intended Learning Outcomes

By the end of this course unit, students should be

-

Able to demonstrate clear knowledge of the principles of statistical pattern recognition.

-

Able to apply simple classification models to applied problems in machine learning and be able to quantify their performances.

-

Systematically apply Machine Learning methods to a new problem and quantify uncertainty in the results.

-

Apply more sophisticated machine learning modes such as Artificial Neural Networks and Support Vector Machines to real datasets and be able to make judicious choices among the various methods available.

-

Able to appreciate the importance variable selection in high dimensional problems that are known to suffer from the curse of dimensionality.

Syllabus Outline

Content

Hours

L

T

L/ F

A

1. Introduction to Machine Learning:
Biological and Statistical motivations; Machine Learning viewed as quantitative tool in Artificial Intelligence; Supervised, Unsupervised and Reinforcement learning; Review of recent advances in Computer Vision, Speech and Dialogue, Recommender Systems, Bioinformatics and Game playing(e.g. GO)

2

2. Review and Background Material:
Linear Algebra and matrix methods, Probability theory including multivariate Gaussian density and its properties, Calculus and Convex Optimisation.

2

1

3. Bayesian pattern classification:
Bayes Optimal classification with simple (Gaussian) distributions; Posterior probabilities and class boundaries; Distance-to-mean classifier; Mahalanobis distance; Quadratic and k-nearest neighbour classifier; Fisher Linear discriminant analysis; Classifier Performance; ROC curve

4

1

3

2

4. Linear Regression:
Mean squared error and closed form solution, sequential estimation

via recursive least square (RLS); Gradient descent solution; Regularisation (l2 and l1 penalties and their properties); Variable selection

2

1

3

1

5. Perceptron algorithm and Proof of convergence

2

6. Nonlinear models:
Radial Basis Functions and Multi-Layer Perceptron; Learning algorithms (Error back propagation and its variants); Deep Learning

2

1

3

1

7. Support Vector Machines:
Maximum margin principle and Optimisation methods; Support Vectors in classification and regression

4

1

3

1

8. Unsupervised Learning:
Clustering, Mixture models and the EM algorithm

2

1

3

1

Total

20

6

15

6

Assessment/Evaluation Details:
Assessment Type
Assessment Method
Percentage
In course assessment
Assignment
10

Lab report
10
Mid semester assessment
20
End of course evaluation
End semester examination
60
Code

EC9640

Title

Artificial Intelligence

Academic

Credits

02

Prerequisite/s None

Intended Learning Outcomes

By the end of this course unit, students should be able to

○ explain the fundamental principles of Artificial Intelligence;

○ Apply the basic principles, models, and algorithms of Artificial Intelligence to solve problems;

○ Demonstrate the ability to implement Artificial Intelligence based solution.

Syllabus Outline

Content

Hours

L

T

L/F

A

1. Introduction

Fundamentals of Artificial Intelligence.

01

2. Solving problems by searching

Heuristic Search: A*; Optimization: Generate and Test, Simple

Hill-Climbing, Steepest-Ascent Hill-Climbing; Adversarial

Search: Games, Optimal Decisions in Games, Alpha-Beta

Pruning.

06

02

03

3. Knowledge based system representation and inference
Propositional and Predicate logic; Inference in First-Order logic:
Forward chaining, backward chaining, Constraint logic
programming, Resolution; Knowledge Representation; Classical
Planning;
06
02
03
4. Expert Systems
Introduction to Expert Systems; Architecture of Expert Systems;
Applications of Expert Systems.
02
5. Natural Language Processing
Language Models; Applications: Text classification, Information
Retrieval, Information Extraction.
03
6. Artificial Intelligence Applications
02
18
20
04
06
18

Assessment/ Evaluation Details:

Textbooks and References:

1. Peter Norvig and Stuart J. Russell, “Artificial Intelligence: A Modern Approach”,3rd edition.

Assessment Type
Assessment Method
Percentage
In-Course Assessment
Assignment
25
Quiz

10
Lab/Field Work
5
Mid Semester Assessment
20
End of Course
Evaluation
End Semester Assessment
40