**Annexure-I**

**PROPOSED FRAMEWORK OF ELECTIVE PHD COURSES AND CURRICULUM**

**(FROM BATCH 2022 TO ONWARDS)**

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| **PROPOSED FRAMEWORK OF PHD COURSES IN**  **ELECTRONIC ENGINEERING** | | | |
| **S. No.** | **Subject Title** | **Course Code** | **Credit Hours** |
| 1. | VLSI Design | ES-811 | 3+0 |
| 2. | Instrumentation and System | ES-816 | 3+0 |
| 3. | Modelling and Simulation of Advanced Systems | ES-821 | 3+0 |
| 4. | Embedded System Design and Applications | ES-826 | 3+0 |
| 5. | FPGA Based System Design | ES-831 | 3+0 |
| 6. | Linear Multivariable Control Systems | ES-836 | 3+0 |
| 7. | Advanced Control systems | ES-841 | 3+0 |

**MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO**

**DEPARTMENT OF ELECTRONIC ENGINEERING**

**INSTITUTE OF INFORMATION AND COMMUNICATIONTECHNOLOGIES**

**Elective course**

**Title of Subject : VLSI Design (ES-811)**

Disciplines : PhD Electronic Engine3ering

Semester : 2nd

Effective : 22nd Batch and onwards

Pre-Requisites : Advanced Integrated Circuit Design (ESE-621)

Assessment : Sessional Work: 10% Mid Semester: 30% Final Semester: 60%

Credit Hours : 3+0 Minimum Contact Hours : 42

Maximum Marks : 100 + 00

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| **Aims and Objectives :** | This course provides concepts associated with the analysis and design of integrated circuits (IC) in the state of the art CMOS technologies. Modern VLSI ICs contain more than two billion components per chip. Design and manufacturing of semiconductor devices present unique challenges, especially at the conceptual and design levels, therefore computer-assisted design (CAD) methods are sought to help manage these complex design. Furthermore, focus is on CMOS technology. Issues to be covered include deep submicron design, clocking, power dissipation, CAD tools, simulation, verification, testing, and design methodology. VLSI and Microelectronics will prepare students for leading-edge positions in industry within the growing areas of VLSI and microelectronics. |

**Contents:**

* VLSI Technology and Trends:
  + Design challenges of Technology scaling,
  + New trends in design automation, VLSI micro-architecture,
* Design challenges for low power.
* Circuit design with CMOS:
* MOS scaling of interconnection, Optimization techniques and their applications in VLSI design.
* Design Process of a VLSI IC
* Design process for complex structures,
* Fault simulation and physical design.
* Design of Semiconductor Memories.
* Design automation and verification,
* Simulate the transistor level behavior of subsystems.

**Recommended Books:**

1. Modern VLSI design A system approach by Wayne Wolf. Prentice-Hall International, Inc., Latest Edition.
2. CMOS VLSI Design: A Circuits and Systems Perspective 4th Edition by Neil Weste, David Harris.
3. Modern VLSI Design: IP-Based Design, Latest Edition by Wayne Wolf Ph.D.
4. Modern VLSI Design: System-on-Chip Design, latest Edition by Wayne Wolf Released January 2002 Publisher(s): Pearson

**Approval:**

Board of Studies Res. No. 1.1 Dated: 23.05.2022

Board of Faculty Res. No.19.6 Dated: 03.06.2022

Advance Studies& Research Board Res. No.184.10 (a) Dated: 06.07.2022

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**Elective course**

**Title of Subject : Instrumentation and Systems (ES-816)**

Disciplines : PhD Electronic Engineering

Semester : 2nd

Effective : 22nd Batch and onwards

Pre-Requisites : Electronic Instrumentation and Data Acquisition System (ESE-601)

Assessment : Sessional Work: 10% Mid Semester: 30% Final Semester: 60%

Credit Hours : 3+0 Minimum Contact Hours : 42

Maximum Marks : 100 + 00

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| **Aims and Objectives :** | To Teach the methods for the measurement and control of systems including numeric control systems, programmable controllers, and distributed systems. |

**Contents:**

* Review ofmeasurement systems,
* design of various transducers, sensors and its applications.
* Design of signal conditioning circuits
* Design of transmitters,
* Automatic testing of electronic devices,
* Field instrumentation, Industrial electronic circuit applications,
* interfacing process variables, motor control and servo systems,
* servo amplifiers and drives,
* numeric control systems,
* programmable controllers and distributed control systems.

**Recommended Books:**

1. Mike Tooley, “PC Based Instrumentation and Control,” Third Edition, 2005, Newnes, ISBN: 0750647167
2. Thomas E. Kissell, “Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls,” Third Edition, 2003, Prentice Hall, ISBN: 0130602418.
3. Chester L. Nachtigal, “Instrumentation and Control: Fundamentals and Applications,” 1990, John Wiley & Sons, ISBN: 0471880450

**Approval:**

Board of Studies Res. No. 1.1 Dated: 23.05.2022

Board of Faculty Res. No.19.6 Dated:03.06.2022

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**Elective course**

**Title of Subject : Modelling and Simulation of Advanced Systems (ES-821)**

Disciplines : PhD Electronic Engineering

Semester : 2nd

Effective : 22nd Batch and onwards

Pre-Requisites : Control systems (ES-353)

Assessment : Sessional Work: 10% Mid Semester: 30% Final Semester: 60%

Credit Hours : 3+0 Minimum Contact Hours : 42

Maximum Marks : 100 + 00

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| **Aims and Objectives :** | This course enables the students to design conventional, adaptive, nonlinear and intelligent control systems.  After completion of this course, students should be able to:   * Develop mathematical models of commonly used control systems. * Analyse a control system in time and frequency domain. * Design and tune PID controllers. * Design adaptive and/or nonlinear systems * Understand the essentials of soft computing and simulation and apply in control system design |

**Contents:**

* Modelling of dynamical systems,
* System Analysis:
  + Transient and steady state analysis of linear time invariant systems,
  + stability analysis
* Design of compensators
* Design and tuning of
  + Proportional controller
  + proportional plus derivative controller
  + proportional plus integral controller
  + proportional plus integral plus derivative (PID) controllers
  + Design example
* Adaptive Control Systems
* Sliding mode control, other nonlinear control techniques.
* Soft computing:
  + Neural Network
  + Fuzzy logic control,
  + Neuro-fuzzy controllers
  + Design example
* Numerical Simulation of Dynamic Systems
  + Simulation Tools
  + Simulating Linear Systems
  + Simulating Nonlinear Systems
  + Building Integrated Systems
* Studying a System with a Simulation
  + Continuous time simulation
  + Discrete time simulation

**Recommended Books:**

1. Stoline J-J F, “Applied Nonlinear control”, Prentice Hall, Latest Edition.
2. AstormK. J.; Wittenmark B.; “Adaptive Control”, Addison- Wesley Latest Edition.
3. Nguyen H.T, Prasad N.R.; Walker C.J.; Walker F.A.; “A First course in Fuzzy and Neural Control” Chapman and Hall/CRC, Lastest Edition.
4. Modern Control Engineering”, K. Ogata, Prentice Hall, Latest Edition.
5. [Charles M. Close](https://www.wiley.com/en-ar/search?pq=%7Crelevance%7Cauthor%3ACharles+M.+Close), [Dean K. Frederick](https://www.wiley.com/en-ar/search?pq=%7Crelevance%7Cauthor%3ADean+K.+Frederick), [Jonathan C. Newell](https://www.wiley.com/en-ar/search?pq=%7Crelevance%7Cauthor%3AJonathan+C.+Newell), “Modeling and Analysis of Dynamic Systems, Latest Edition
6. P. P. J. van den Bosch, A. C. van der Klauw, “Modeling, Identification and Simulation of Dynamical Systems”, latest edition.
7. Mutanmbara A.G.O.; Design and analysis of Control Systems, Taylor and Francis, Latest Edition

**Approval:**

Board of Studies Res. No. 1.1 Dated: 23.05.2022

Board of Faculty Res. No.19.6 Dated:03.06.2022

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**Elective course**

**Title of Subject : Embedded System Design And Applications (ES-826)**

Disciplines : PhD. Electronic Engineering

Semester : Second

Effective : 22nd Batch and onwards

Pre-Requisites : Embedded System Design (ES-423)

Assessment : Sessional Work: 10% Mid Semester: 30% Final Semester: 60%

Credit Hours : 3+0 Minimum Contact Hours : 42

Maximum Marks : 100 + 00

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| **Aims and Objectives :** | Main objectives of the subject is to be able to design and program Arm-based embedded systems and implement them using commercial API. ARM Cortex-M3 and Cortex-M4 at application level with computing facility at chip locally. |

**Contents:**

**Edge Computing**

* Computing Paradigms
* Edge Computing and its Essentials.
* Edge Analytics
* Edge Data Storage Security
* Blockchain and Edge Computing Systems
* Edge Computing Use Cases and Case Studies.

**The Arm Cortex-M Processor Architecture**

* ARM Cortex-M Processors Architecture, Programming model
* Applications & Advantages of the ARM Cortex-M processors
* Tools & Resources for using ARM processors and ARM microcontrollers
* Communication protocols
* Low power design and features for resource constrained systems

**Cortex-M Programming & Embedded Software Development**

* Software development flow
* Microcontroller interfaces
* The Cortex M Microcontroller software interface standard (CMSIS)
* Mbed SDK
* Real-Time Operating Systems (RTOS)

**ARM Cortex -M4 and DSP Applications**

* DSP of on a microcontroller
* Architecture of a traditional DSP processor
* Optimized DSP code for Use Cases and Case Studies

**ARM Cortex-M4 and FPGA Applications**

* System on Chip SoC
* Software and resources for FPGA designs
* ARM- Based SoC FPGA Use Cases and Case Studies

**Recommended Books:**

1. The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, Latest Edition, By Joseph Yiu ARM Ltd., Cambridge, UK-Elsevier
2. ARM® Cortex® M4 Cookbook by Dr. Mark Fisher, Pakt Publishing, Latest Edition
3. Getting Started with Tiva ARM Cortex M4 Microcontrollers A Lab Manual for Tiva LaunchPad Evaluation Kit by Dhananjay V. Gadre • Sarthak Gupta, Latest Edition
4. Edge Computing Fundamentals, Advances and Applications By K. Anitha Kumari, G. Sudha Sadasivam, D. Dharani, M. Niranjanamurthy, ISBN 9781032126081, Published December 23, 2021 by CRC Press. Latest Edition

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**INSTITUTE OF INFORMATION AND COMMUNICATIONTECHNOLOGIES**

**Elective course**

**Title of Subject : FPGA Based System Design (ES-831)**

Disciplines : PhD Electronic Engineering

Semester : 2nd

Effective : 22nd Batch and onwards

Pre-Requisites : FPGA Based Digital Design (ES-373)

Assessment : Sessional Work: 10% Mid Semester: 30% Final Semester: 60%

Credit Hours : 3+0 Minimum Contact Hours : 42

Maximum Marks : 100 + 00

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| **Aims and Objectives :** | A Field programmable Gate Array (FPGA) is an integrated circuit that is designed to be configured after manufacturing. It combines together the flexibility of microprocessor and high performance of an Application Specific Integrated Circuit (ASIC). FPGAs can be used to implement any logic function that an Application Specific Integrated Circuit (ASIC) can perform.  This course will introduce FPGA-based system design techniques using VHDL. Advanced hardware optimization techniques, and some major design examples will also be reviewed. |

**Contents:**

* FPGA-based design: Real needs and limits, FPGA Reconfiguration
* SoCdesign on FPGA
* High level synthesis for FPGA–Vivado and VivadoHLS
* Finite State Machines
* Register Transfer methodology
* Pipelining
* Hierarchical Design in VHDL
* Timing analysis
* Implementing applications with FPGA
* Instance-specific design
* Precision analysis for Fixed point Computation
* Distributed Arithmetic
* Hardware/Software partitioning
* Multi-FPGA Systems : Logic Emulation
* The implications of floating point for FPGAs
* Summary of latest research trends regarding FPGA based Systems and Reconfigurable Computing.

**Recommended Books:**

1. Pong P Chu, 2006, “RTL Hardware Design Using VHDL-Coding for Efficiency, Portability and Scalability”, John Wiley & Sons, Inc., Latest Edition.
2. Scott Hauck, Andre Dehon, 2008, “Reconfigurable Computingthe theory and practice of FPGA-based computing”, ELSEVIER, Inc., Latest Edition.
3. Steve Kilts, 2007, Advanced FPGA Design- Architecture, Implementation, and Optimization, John Wiley & Sons, Inc., Latest Edition.
4. Wayne Wolf, 2004, “FPGA-Based System Design”, Pearson Education, Latest Edition.

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**INSTITUTE OF INFORMATION AND COMMUNICATIONTECHNOLOGIES**

**Elective course**

**Title of Subject : Linear Multivariable Control Systems (ES-836)**

Disciplines : PhD Electronic Engineering

Semester : 2nd

Effective : 22nd Batch and onwards

Pre-Requisites : Modelling and Control of Dynamic Systems (ESE-611)

Assessment : Sessional Work: 10% Mid Semester: 30% Final Semester: 60%

Credit Hours : 3+0 Minimum Contact Hours : 42

Maximum Marks : 100 + 00

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| **Aims and Objectives :** | This course aims to enable the students to obtain an understanding of theory and design of multivariable linear time-invariant (LTI) control systems. The students will know the estimator’s theory and multivariable linear time-invariant controller design.  The students shall know necessary background needed to understand optimal control and to apply the modern H-infinity control theory based robust control design techniques. |

**Contents:**

* Multivariable control: State-space dynamic systems (continuous-time and discrete time), stability, Observability and controllability,
* PID Controller design,
* Closed-loop estimator design,
* MIMO frequency response,
* Vector random (stochastic) processes,
  + Discrete-time systems
  + Continuous-time systems
* Optimal Linear Quadratic Regulator (LQR)
  + Optimization
  + Infinite-horizon discrete-time LQR problem
  + Finite time LQR problem
  + Design example
  + Deterministic least squares, stochastic least squares, Metrics for estimates, Recursive estimation,
* Optimal estimator design
* Kalman Filter,
  + Continuous-time filters,
  + Steady-state Kalman filters,
* Frequency-domain interpretation, Symmetric root locus, Relationship between LQE and LQR. Full-information control, The Hamiltonian equation, Riccati equation to find state feedback,
* H∞ estimation,
  + Norms for signals and systems
  + State-Space Solution of the Multivariable H∞ Optimal Control Problem,
  + H∞ Optimal Controller.
* Servomechanisms
  + Signal Generators and the Servo controller,
  + Multivariable Control using SISO Methods,
  + A Scalar Equivalent of a MIMO System,
  + Stability Margin Calculations,
  + SISO Design Methods for MIMO Systems,
  + Multivariable Servomechanism Design Using SISO Methods,
  + MIMO Stability Margin Calculations.

**Recommended Books:**

1. Shankar P. Bhattacharya, Linear Multivariable Control Systems, Texas A &M university, Latest edition
2. Jeffrey B. Burl, Linear Optimal Control: H2 and Methods, Addison-Wesley, Menlo Park, CA, Latest edition
3. D. Liberzon, Calculus of Variations and Optimal Control Theory: A Concise introduction, Princeton University Press, Latest edition

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Board of Studies Res. No. 1.1 Dated: 23.05.2022

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**Annexure-B**

**MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY, JAMSHORO**

**DEPARTMENT OF ELECTRONIC ENGINEERING**

**INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES**

**Elective course**

Title of Subject : **Advanced Control systems (ES-841)**

Disciplines : PhD Electronic Engineering (ES)

Semester : First

Effective : 21st Batch and onwards

Assessment : Sessional Work: 10% Mid Semester: 30% Final Semester: 60%

Credit Hours : 3+0 Minimum Contact Hours : 42

Maximum Marks : 100 + 00

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| **Aims and Objectives :** | This course aims to enable the students to obtain an understanding of fuzzy logic systems and artificial neural networks. The students will know how these techniques are applied to engineering problems, including control systems. Students will be aware of current research trends and issues towards advanced control systems. Students will be able to design advanced control systems using fuzzy logic and neural network with soft computing methods. |

**Contents:**

* Introduction to advanced control systems
* Neural Networks control system
  + Neural Network Architectures
  + Learning in Neural networks
  + Application of Neural Network to modelling, estimation and control
* Fuzzy logic control system
  + Fuzzy sets, Fuzzy Rules and Fuzzy Reasoning
  + Fuzzy Inference Systems
  + Fuzzy logic control
* Nonlinear control
* Nonlinear control
* Derivative-Based Optimization
  + Derivative-Based Fuzzy System Optimization
* Derivative-Free Optimization
* Genetic algorithms in optimization
* Adaptive Networks
* Application of Advanced control system
  + Adaptive Neuro-Fuzzy Inference Systems (ANFIS) To Robotics
  + Computational Intelligence Approach to Object Recognition
  + Genetic and evolutionary Methods for Mobile Robot Motion Control and Path planning

**Recommended Books:**

1. J-S. R. Jang, C-T. Sun, and E. Mizutani, Neuro-Fuzzy and Soft Computing, Prentice Hall, Latest Edition
2. Stamatios V. Kartalopoulos, Understanding Neural Networks and Fuzzy Logic: Basic Concepts and Applications, Wiley-IEEE Press, latest edition.
3. Y. Sin and C. Xu, Intelligent Systems: Modeling, Optimization, and Control, CRC Press, Latest Edition.
4. Sankar K. Pal and Sushmita Mitra, Neuro-Fuzzy Pattern Recognition: Methods in Soft Computing, John Wiley & Sons, Latest edition
5. Timothy J. Ross,Fuzzy Logic With Engineering Application, John Wiley & Sons, Latest edition.

Approval:

Board of Studies Res. No. 45.3 Dated: 24.12.2020

Advance Studies& Research Board Res. No. 172.28 (a) Dated: 26.04.2021

Academic Council Res. No. 100.12(ii) Dated: 24.08.2021