Course number and name

1. **Course number and name**
   EE 324: Fundamentals of Digital Systems

2. **Credits and contact hours**
   4 (3 lecture hours and 3 lab hours per week)

3. **Instructor's or course coordinator's name**
   Clint Cole

4. **Text book, title, author, and year**
   John F. Wakerly. 2018. *Design Principles and Practices* (5th ed.). (Optional)
   Project Materials: (design projects, exercises, reading): <www.realdigital.org>.
   Other supplemental materials
   Blackboard circuit board (*Real Digital*); Vivado Webpack (*Xilinx*); Instructor notes and slides for some topics

5. **Specific course information**
   a. *Catalog description:* Design and analysis digital systems emphasizing synchronous circuits for control, communication, and signal and data processing; tightly coupled hardware/software systems; use of modern CAD tools and technologies; basic system-level electronics.
   b. *Prerequisites or co-requisites:* EE214; EE234

6. **Specific goals for the course**
   At the end of this course, students must be able to:
   - Correctly construct arbitrarily complex combinational and sequential digital circuit models using Verilog (1,2,6)
   - Simulate, synthesize, and validate digital systems using modern design technologies and CAD tools (1,2,6)
   - Know how to process input and output signals to and from different clock domains (1,2,6)
   - Be able to construct digital IP blocks that are addressable via the AXI bus (1,2,6)
   - Be able to implement sequential behaviors using hardware or software-based solutions (1,2,6)
   - Be able to create and evaluate different implementations to meet a stated behavioral requirement (1,2,6)
   - Be able to codesign circuits and interface them with designs from other engineers (3,5)
   - Present technical design details to a design review team (3,5)

7. **Brief list of topics to be covered**
   - Review of combinational and sequential circuits and design methods,
   - The Verilog language, syntax and modelling methods,
   - Verilog timing and simulator models,
   - Inputs and outputs to and from sequential circuits,

- Clock management and transitioning data between clock domains,
- System reset considerations,
- FPGA and programmable device architectures,
- AXI bus overview, signaling protocols, and timing/control,
- Multiple sequential circuits and their coordination,
- Logic system synthesizers overview,
- Hardware/software codesign, tradeoffs, and partitioning,
- CAD tool topics: output files, timing analyzer, floor planner, and IP integrator.

1.

2. **Credits and contact hours**
   3 credits, 3 contact hours per week

3. **Instructor's or course coordinator's name**
   Sandip Roy

4. **Textbook, title, author, and year**
   Nilsson and Riedel. 2019. *Electric Circuits* (11ed.). Pearson. ISBN-13: 978-0-13-474696-8.
   Other supplemental materials
   Also, lecture notes are provided to the students.

5. **Specific course information**
   a. *Brief description:* EE 321 enhances the students' introduction to linear circuit analysis toward a systematic solution and design methodology, based on differential-equation formalisms. This general circuit analysis serves as a starting point toward an introduction to core tools in systems and signals analysis for electrical engineers.
   b. *Prerequisites or corequisites:* Completion of Circuits I (EE 261) and Differential Equations with grade of C or better, or permission of instructor.

6. **Specific Goals and Objectives**:
   EE 321 provides a development of core systems and signals concepts, and their application to linear circuits analysis and design. By the end of the course, students should be able to
   a) write differential-equation models for linear circuits, and to put these circuit differential equations into standard, state-space-, and Laplace-domain forms;
   b) solve linear differential equations or circuits using several methods, including the method of undetermined coefficients, the convolution-based approach, Laplace-domain solutions, and state-space-based solutions (by computer);
   c) understand core system-theory concepts and constructs such as the transfer function, frequency response, and impulse response;
   d) design and analyze filter circuits;
   e) understand the operation of mutual inductors, as an additional circuit component;
   f) understand and be able to apply several mathematical techniques underlying systems/signal analysis, including Laplace-domain analysis, Fourier Series, and Fourier Transforms.

   By the end of the course, students should be able to:
   - Apply circuits-engineering principles to analyze linear dynamic circuits (Outcomes 1a-1e)
   - Design linear dynamic circuits that meet performance specifications such as filter and time-domain specification (Outcomes 2a-2g)

- Communicate motivations, methods, and outcomes for circuit design tasks such as filter design (Outcomes 3a-3e)
- Work in teams to analyze and design circuits (Outcome 5b)
- Apply knowledge and information to analyze/design circuits (Outcomes 6a, 6c)

7. Brief List of Course Topics

- Developing differential-equation models for linear circuits
- Solving differential equations using the method of undetermined coefficients
- Using convolution to solve circuits/differential equations
- Solving circuits and differential equations by computer using the state-space form
- New circuit elements: mutual and ideal transformers
- Laplace Transform mathematics
- Solving circuits and differential equations using Laplace transforms
- Core system-theoretic concepts: transfer function and impulse response
- Frequency response (including drawing and interpreting Bode plots)
- Design of filter and amplifier circuits
- Fourier series: mathematics
- Fourier series: application to circuits and systems analysis
- Fourier transforms: introduction