

# KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

## Electrical Engineering Department

### EE-416 Analog Filter Design

**Instructor:** Dr. Hussain Alzaher, [alzaherh@kfupm.edu.sa](mailto:alzaherh@kfupm.edu.sa), Tel. 860-1434 **Office Hours:**

(I) Undergraduate Bulletin: Properties of network functions, Design of lossless two-port networks, Filter characteristics approximation: Butterworth, Chebyshev, Elliptic, and Bessel approximations. Frequency transformation. Design of active RC filters using operational amplifiers. Nonideal effects. Design using OTA's. Design using "MOSFET-C" circuits. Introduction to switched capacitor filters.

(II) Suggested

Properties of network functions:

- 1) General Characteristics of Filters
- 2) Approximation
- 3) Frequency Transformation
- 4) Sensitivity and Selectivity

Passive Filters:

- 5) Introduction, Second-order sections, High-order Filters: Cascade and LC Ladder
- 6) Two-port synthesis by Ladder Development  
Ladder simulations by GIC, Operational Simulation  
*State-Variable Synthesis Techniques (Leapfrog topology)*
- 7) Design of Resistively Terminated Networks
- 8) Design of Broadband Matching Networks

Active Filters

- 9) Single-amplifier Filters
- 10) Multiple-amplifier Biquads
- 11) Generalized Immittance Converter (GIC) Biquads
- 12) Higher-Order Filters

Filters, Delay Filters:

- 1) Time-Delay and Transfer Function
- 2) Equalization Procedure
- 3) Equalization with first-order and second-order modules

Continuous-Time Integrated Filters

- 13) Transconductance-C filters:
  - (a) A model of Transconductance Cells
  - (b) Elementary Transconductor Building Blocks
  - (c) First and Second-order Section
  - (d) High-order Filters: Cascade and Ladder

Switch Capacitor Filters

*Applications*

Hearing aid Filters, Mobile Phones Baseband Filters, Bluetooth Filters, WirelessLAN, Biomedical.

*Computer analysis*

### References (Supplemental)

- [1] Handouts of current international publications.
- [2] Some well recognized texts on the subjects.

### Assessment Policy

1. HW and Quizzes 20 %      Two Exams 40%      Project 10%      Final 30%