University of Tehran
School of Electrical and Computer Engineering

Course:	**8101290 - Filter and Circuit Synthesis**
Course type:	EE*: Com ☐, E ☒, P ☐, B ☐, Con ☐, D ☒ — CE*: SW ☐, HW ☐, IT ☐ — Credit: 1 Required ☐ ☒ ☐ ☐ ☐ ☒ ☐ ☐ ☐ Elective ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Level:	Undergraduate ■ Graduate ☐
Co-requisite(s):	None.
Prerequisite(s):	Electronics 2 (8101088)
Prerequisite by topic:	Laplace transform, Analysis of RLC circuits, Frequency response and Bode diagram, Opamp application circuits
Textbook(s):	[1] Harry Y-F. Lam, "Analog and Digital Filters, Design and Realization," Prentice Hall, 1979. [2] H. R. Khodadadi, "Filter Design and Circuit Synthesis, with Computer Projects, 3rd Edition," Imam Hossein University Press, Language: Farsi.
Coordinator:	Samad Sheikhaei, Assistant Professor , School of ECE
Goals:	In this course, the students become familiar with the design and synthesis of filter circuits and their applications. The filter is specified either by its amplitude and phase response, or amplitude and group delay response. The students learn how to approximate those specifications by a transfer function in the *s* domain. Those approximations could be in a general format, or special formats, such as Butterworth, Chebyshev I, Chebyshev II, Elliptical, or Bessel. Then, the students learn to realize such a transfer function, using a passive circuit, taking advantage different techniques, including driving point functions (input/output impedance/admittance) calculation and implementation. Afterwards, they will learn different methods of active filter implementation, including Opamp-RC and OTA-RC filter circuits. Computer assignments using Matlab, Spice, and filter design tools are complementary for the education of students in this course.
Outcome:	Upon successful completion of the course, students will be able to 1. Approximate a filter specified with amplitude and phase, or amplitude and delay, using a *s* transfer function. 2. Find the input/output impedance/admittance for a given *s* transfer function. 3. Design a passive circuit for a given input/output

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	impedance/admittance. 4. Convert a passive filter realization to an active one. 5. Select appropriate filter type, among Butterworth, Chebyshev I, Chebyshev II, Elliptical, or Bessel, based on the required filter properties. 6. Decompose a *s* transfer function to the first or second order factors, and realize them using available filter libraries, and cascade those circuits. 7. Design active filters using Opamp-RC or OTA-C (Gm-C) circuits.
Topics:	1. Introduction 2. PR (Positive Real) Functions 3. Realization of Driving Point (Impedance/Admittance) Functions - LC Networks - RC Networks 4. Passive Realization of Filter Transfer Functions 5. Filter Approximation - Butterworth, Chebyshev I, Chebyshev II, Elliptical, and Bessel Filters 6. Active Opamp-RC Filter Realization 7. Active OTA-C Filter Realization
Computer usage:	Circuit design tools such as Spice. Filter design tools such as Filter Solutions. Mathematical tools such as Matlab.
Assignments:	7 or 8 homework or computer assignments.
Projects:	One or two projects of design and simulation (and optional physical implementation) of passive and active filters
Grading:	Assignments: 10 % Projects: 10 % Quizzes: 10 % Midterm exam: 30 % Final exam: 40 %
Further readings:	[1] L. Wanhammar, "Analog Filters Using MATLAB," Springer, 2009. [2] R. Schaumann, H. Xiao, and M. Van Valkenburg, "Design of Analog Filters, 2nd Edition," Oxford University Press, 2009. [3] M.E. Van Valkenburg, "Analog Filter Design," Oxford Series in Electrical and Computer Engineering, 1995.
Prepared by:	S. Sheikhaei, Assistant Professor , School of ECE
Date:	September 2017

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*EE: Electrical Engineering		CE: Computer Engineering	
Com	Communications	SW	Software
E	Electronics	HW	Hardware
P	Power	IT	Information Technology
B	Bioelectronics		
Con	Control		
D	Digital System		