University of Tehran
School of Electrical and Computer Engineering

<table>
<tr><td>Course:</td><td>Terahertz Technology</td></tr>
<tr><td>Course type:</td><td>
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<tr><td></td><td colspan="6">EE*</td><td colspan="3">CE*</td><td rowspan="2">Credit: 3</td></tr>
<tr><td></td><td>Com</td><td>E</td><td>P</td><td>B</td><td>Con</td><td>D</td><td>SW</td><td>HW</td><td>IT</td></tr>
<tr><td>Required</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td></td></tr>
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<tr><td>Level:</td><td>Undergraduate ☐
Graduate ■</td></tr>
<tr><td>Co-requisite(s):</td><td>None</td></tr>
<tr><td>Prerequisite(s):</td><td>Microwave I, Antenna I</td></tr>
<tr><td>Prerequisite by topic:</td><td>Fundamental of wave propagation, high frequency electronics</td></tr>
<tr><td>Textbook(s):</td><td>[1] Yun-Shik Lee, Principles of Terahertz Science and Technology, Springer, 2009.
[2] Erik Brundermann, Heinz-Wilhelm Hubers, Maurice FitzGerald Kimmitt, Terahertz Techniques, Springer, 2012.
[3] Recent papers in the field.</td></tr>
<tr><td>Coordinator:</td><td>M. Neshat, Assistant Professor</td></tr>
<tr><td>Goals:</td><td>This course gives an insight into the electromagnetic spectrum in terahertz and millimeter-wave (MMW) range, namely 0.1-10 THz. In this course different photonic and electronic techniques for THz/MMW generation and detection are introduced. THz radiation absorption, resonance effects and models of dielectric function are investigated. Quasi-optical reflective and refractive components such as off-axis parabolic mirrors and dielectric lenses are discussed. Moreover, different guiding and antenna structures suitable for this range of the spectrum are introduced. THz measurement techniques, such as THz time-domain spectroscopy are discussed. Finally, various important applications of this frequency band including sensing, spectroscopy and imaging are presented.</td></tr>
<tr><td>Outcome:</td><td>Upon successful completion of the course, students will be able to

1) Become familiar with various photonic and electronic techniques for THz/MMW generation and detection.
2) Understand the material dispersion and loss mechanism in</td></tr>
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	THz range. 3) Design various THz/MMW components such as waveguide, antenna, filter and etc. 4) Become familiar with measurement techniques in THz/MMW range. 5) Learn about some important applications offered by THz technology such as sensing, spectroscopy, imaging and etc.
Topics:	1) **Introduction:** MMW/THz band, its unique properties not seen in other electromagnetic bands, potential applications 2) **THz Sources:** photoconduction-based, semiconductor-based and nonlinearity-based, etc. 3) **THz detectors:** power detectors and coherent receivers 4) **Interaction of THz wave with matter:** THz absorption, resonance effects and models for dielectric function in THz range 5) **THz components**: Antennas, waveguides, filters, refractive and reflective optics, etc. 6) **THz measurement techniques**: THz time-domain spectroscopy, THz ellipsometry, etc. 7) **THz applications and systems**: sensing, spectroscopy, imaging, tomography, communication, etc.
Computer usage:	Ansys HFSS, Comsol Multiphysics, Silvaco, Matlab
Assignments:	6 homework assignments
Projects:	Literature review and research presentation on the latest advancement in THz/MMW technology
Grading:	Assignments: 30% Projects: 20% Midterm exam: 20% Final exam: 30%
Further readings:	[1] Kiyomi Sakai, *Terahertz Optoelectronics*, Springer, 2005. [2] X.-C. Zhang, Jingzhou Xu, *Introduction to THz Wave Photonics*, Springer, 2010. [3] Daniel Mittleman, ed., *Sensing with Terahertz Radiation*, Springer, 2004. [4] Susan L. Dexheimer, ed., *Terahertz Spectroscopy: Principles and Applications* (Optical Science and Engineering Series), CRC Press, Taylor and Francis group, 2008. [5] Dwight L. Woolard, William R. Loerop, Michael S. Shur, ed., *Terahertz Sensing Technology*, Volume 1 & 2, World Scientific, 2003.
Prepared by:	Mohammad Neshat
Date:	November, 2017

*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		