1. *Course number and name*
   ENGR 449: Communication Systems

2. *Credits and contact hours*
   3 credit hours; three 50-minute lecture sessions/week, or two 1-hr-15-minute lecture sessions/week, depending on semester

3. *Instructor's or course coordinator's name*
   Instructor: Prof. Murthy
   Course coordinator: Tom Holton, Ph.D.

4. *Text book, title, author, and year*

   Lathi, B. P. *Modern Digital and Analog Communication Systems.* 3rd ed. Oxford University Press, 1998.

   a. *Other supplemental materials*

   1. Carlson, A. B. *Communication Systems*, 3rd ed. McGraw Hill, 1986.
   2. Couch, L. W. *Digital and Analog Communication Systems.* Macmillan, 1987.
   3. Sklar, B. *Digital Communications: Fundamentals and Applications.* Prentice Hall, 1988.

5. *Specific course information*
   a. *Brief description of the content of the course (catalog description)*
      Review of analog signal and system analysis in the time and frequency domains. AM, FM, and PM modulation and demodulation techniques. Pulse modulation techniques. Digital modulation systems. Error-correcting coding: Block and convolutional codes. Advanced communications technologies.

   b. *Prerequisites or co-requisites*
      A grade of C- or better in ENGR 305

   c. *Indicate whether a required, elective, or selected elective course in the program*
      Required for Electrical Engineering
      Elective for Computer Engineering

6. *Specific goals for the course*
   a. *specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*

- The student can sketch signal waveforms before and after amplitude modulation both in the time and frequency domains.
- The student can design a demodulator given a modulator.
- The student understands SSB, VSB, and QAM.
- The student is able to compare modulation schemes regarding their power and bandwidth efficiencies.
- The student demonstrates an understanding of mathematics associated with frequency and phase modulation and demodulation.
- The student can sketch signal waveforms before and after frequency modulation both in the time and frequency domains.
- The student can design an FM demodulator.
- The student demonstrates an understanding of how sampling rate is related to aliasing in converting analog signals to discrete samples.
- The student understands the advantages of digital communications over analog communications.
- The student understands how PCM is encoded and the reasons behind the resulting bit rate.
- The student understands why digital data are line coded and pulse shaped before transmission.
- The student understands why ISI is caused by pulse shaping and what the Nyquist filter is. *T*he student can perform scrambling and is able to design a descrambler given the scrambler.
- The student understands equalization and is able to design a linear equalizer. The student understands digital modulation.
- The student can sketch the waveforms of digitally modulated signals for ASK, PSK, FSK, and digital QAM.
- The student is able to draw the constellation diagrams for BPSK, 8PSK, 16 PSK, 4QAM, 16 QAM.
- The student knows cumulative distribution function and probability density function and their properties.
- The student can analyze the performance of the binary symmetric channel.
- The student can analyze the performance of digital modulation (e.g. BPSK) in an AWGN channel.
- The student can perform block coding and decoding.
- The student can obtain the parity-check matrix given the generator matrix and vice-versa. The student can construct the trellis diagram of a convolutional code
- The student can perform decoding of convolutional codes using the Viterbi algorithm.
- The student demonstrates an understanding of mathematics associated with amplitude modulation and demodulation.

b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

Course addresses ABET Student Outcome(s): a, b, c, e

7. *Brief list of topics to be covered*
   - Amplitude modulation and demodulation
   - Frequency modulation and demodulation
   - Sampling theorem, PAM and PCM
   - Line coding and pulse shaping
   - Digital modulation techniques: BPSK, QPSK and FSK

- Probability and random processes. Gaussian and uniform distributions.
- Error-correcting coding. Linear and convolutional codes
- Advanced communications technologies