Please review the “Exam Policies” section of the Exams page at the course web site. Please note the following two changes from policies used in the past:

1. You will be allowed to use one 8.5 × 11-inch two-sided handwritten help sheet. No photocopied material or copied and pasted text or images are allowed. If there is a table or image from the textbook or some other source that you feel would be helpful during the exam, please notify the instructor.

2. All help sheets will be collected at the end of the exam but will be returned to you later.

The following is a list of topics that could appear in one form or another on the exam. Not all of these topics will be covered, and it is possible that an exam problem could cover a detail not specifically listed here. However, this list has been made as comprehensive as possible.

Electromagnetic spectrum (rough idea of frequency ranges and wavelengths)
- MF, HF, VHF, UHF
- AM, FM, and TV/CATV broadcast services
- microwave region and band letter designations (L, S, C, X, Ku, K, Ka)
- millimeter wave region and band letter designations (V, W)
- usefulness of various parts of spectrum for specific services/purposes

Basic wireless system
- baseband signal
- transmitters and receivers
- the use of radio is a kind of frequency division multiplexing
- transmission lines
- antenna(s)

Decibels
- definition; advantage over using power ratios
- application to power gain vs. voltage gain
- overall gain/loss of a system
- mathematical identities involving logarithms
- dBm, dBW units
- use of dBm (or dBW) vs. dB – absolute vs. relative quantities

Concept of $\Gamma$, VSWR, and return loss as measures of impedance match quality (with or w/o xmsn line):
$$\Gamma_L = \frac{Z_L - Z_o}{Z_L + Z_o} \quad \text{VSWR} = \frac{1 + |\Gamma_L|}{1 - |\Gamma_L|} \quad \text{RL} = -20 \log |\Gamma_L| \quad \text{(pos. quantity)}$$

Realistic models of resistors, inductors, and capacitors
- stray (parasitic) resistance, inductance, and capacitance
- behavior of components at high frequencies (above intended freq. range)
- self resonances of inductors/capacitors
- inductors often have troublesome resistance even at low frequencies

Skin effect (increased resistance of wires at high frequencies)
Impedance matching methods
- LC networks
- quarter-wave transmission line sections
- transmission line stubs
- “good” match criteria often used: $|\Gamma|^2 < 0.1$, VSWR $< 2$, $RL > 10$ dB ($|\Gamma| < -10$ dB)

Quarter-wave sections for impedance matching
- $Z_{oQ} = (Z_iZ_{in})^{1/2}$, where $Z_{oQ}$ is the char. impedance of matching section (not the same as $Z_o$ of line leading up to matching section; that $Z_o$ might equal $Z_{in}$)
- matching bandwidth depends on impedance transformation ratio

L networks for impedance matching (a type of LC matching network)
- concepts of “source” (or “generator”) and “load” impedance
- concept of “lumped element”
- underlying concept: series-to-parallel transformations of resistance and reactance

- $R_p = R_s(Q^2+1)$ or $Q = \sqrt{\frac{R_p}{R_s}} - 1$
- for series combinations, $Q = \frac{|X_s|}{R_s}$
- for parallel combinations, $Q = \frac{R_p}{|X_p|}$

- individual inductors and capacitors have component $Q$; $Q$ of inductors is usually much lower than that of capacitors and can be the limiting factor in network $Q$
- four L network topologies: two for $R_L > R_g$, two for $R_L < R_g$; in each case, can have series-L/shunt-C or series-C/shunt-L (shunt reactance always next to higher resistance)
- If $Q$ is large, $\omega_o^2 \approx \frac{1}{LC}$ and $|X_p| \approx |X_s|$ for all four topologies

- matching bandwidth is inversely proportional to $Q$
- matching bandwidth can be increased by using multiple L network stages
- $r_{stage} = \frac{1}{\sqrt{n}}$, where $n$ = no. stages, $r$ = impedance transformation ratio
- methods for “absorbing” load reactance into matching network
  o shunt element next to load: $X_p = \frac{X_{load}X_{p,total}}{X_{load} - X_{p,total}}$
  o series element next to load: $X_s = X_{s,total} - X_{load}$

Pi and T networks for impedance matching
- consists of two back-to-back L networks
- concept of “virtual” resistance $R_v$:
  o $R_v < R_g$ and $R_L$ for pi network
  o $R_v > R_g$ and $R_L$ for T network
- additional degree of freedom (third component) allows designer to (choose one):
  o control $Q$ (bandwidth) – one side of network dominates $Q$
  o avoid unreasonable $L$ and $C$ values
- choice of topology
  o avoid or allow DC continuity between stages or to ground
  o avoid problems with stray reactance
  o avoid unreasonable $L$ and $C$ values
- minimize no. of inductors (can have significant stray resistance, susceptible to mutual coupling, generally heavier and more expensive than capacitors)
- in general, use T network to match low resistances, pi network to match high resistances

Relevant coursework, textbook sections, and supplemental material:

Homework:  #1, #2
Labs:  #1, #2
Textbook:  Secs. 1.1, 1.2; Sec. 2.11; Secs. 3.1-3.3, 3.5;
Supplements:  “Why Do We Use Decibels?”
excerpt of “Impedance Matching” chapter from C. Bowick, RF Circuit Design