ENGR 201 Winter 2020

Instructional Resources

- Instructor:
  - Karti Mayaram (email: karti@oregonstate.edu)
  - Office KEC 4095 (phone: 737-2972)
  - Office Hours: Mon 5-6pm, Tue 11am-noon

- TA office hours:
  - Posted on Canvas

- Class website
  - http://web.engr.oregonstate.edu/~karti/engr201.html

- Anonymous feedback on class webpage
  (http://web.engr.oregonstate.edu/~karti/engr201.html)
Organization and Policies

• ENGR 201:
  – Lecture Tu/Th 10-10:50am
  – Recitation/Lab sections during the week
    • Problem solving sessions + 3 labs
• All emails should have [ENGR201] in subject line
• Cheating is unacceptable
  – Swift disciplinary action will be taken
• No laptops allowed in class
• No late assignments accepted
• No makeup exam
  – Exception: medical emergency

Grading

• Exams will be closed book
  – Reference note sheet will be provided
  – Calculators will not be allowed
• Midterm Exams (2): 40%  
  – Thu Jan. 30: 10am-10:50am (50 minutes)
  – Thu Feb. 20: 10am-10:50am (50 minutes)
• Comprehensive Final Exam: 25%
  – Mon Mar. 16: 9:30am-11:20am (110 minutes)
• Assignments: 15%
• Recitation Quizzes + Lab Reports: 20%
• Grades: A ≥ 90, B 80-<90, C 70-<80, D 60-<70, F < 60
Recitation/Lab Sections

- Attendance required
  - Recitations start this week
- Labs start Week 4 (Lab kit to be purchased)
  - Lab #1 (Week 4), Lab #2 (Week 7), Lab #3 (Week 9)
- Week 3 Monday (Jan 20) MLK holiday
  - Monday sections - please attend another section during that week
- In a recitation week if you cannot attend your regular section
  - Please inform your section TAs about missing the recitation
  - Also, inform the TAs for the section you will attend

Assignments (Total #7)

- Weekly assignments:
  - Assigned Tue and due on Tue following week
  - No new assignment during midterm week
  - Assignments from Etextbook
    - Regular Assignments
      - Multiple attempts
      - Hints provided in most problems
    - Adaptive followup (extra credit)
Textbook (Etext of Electric Circuits)

• The instructions for purchasing the book are on Canvas
  – Textbook is required
  – Purchase Etext from OSU Bookstore
  – Follow instructions in Canvas to link Canvas and Etext
    • Direct link from Canvas to Etext and Assignments
  – Assignment #0 – Due Thu Jan. 9
    • Introduction to Etext usage

Optional Resources

• Univ. of California Video Course
  – http://cad.eecs.umich.edu/berkeley_videos.html

• Univ. of Utah Video Course
  – https://utah.instructure.com/courses/473597

• Khan Academy

• All About Circuits
  – https://www.allaboutcircuits.com/textbook/direct-current/

• Wikiversity
  – https://en.wikiversity.org/wiki/Electric_Circuit_Analysis
What is this Course About?

Analysis of Circuits or Networks

- What is a circuit?
  - An interconnection of electrical components
  - Example: battery and bulb in a flash light

- The interconnection can be complex

Why do All Engineering Students Need this Course?

- Encounter electric circuits in day-to-day life
  - Household power, appliances, autos, ...
- Engineering is a very interdisciplinary field
  - Micro electromechanical systems (MEMS)
    - Electrical and mechanical systems
  - Bio MEMS
    - Chemical, biological, fluid mechanics, electrical systems
- Interdisciplinary projects/teams need to have an understanding of interactions between disciplines
- Knowledge of electric circuits can be used to analyze other systems
  - Mechanical
  - Heat flow
  - Fluid flow
  - ...
- A fundamental course for ALL engineering students
What does one Learn in this Course?

• Circuit variables
  – Current, Voltage, Charge, Power
• Circuit components
  – R, C, L, independent sources, dependent (controlled) sources
• Basic laws
  – Ohm’s Law
  – Kirchhoff’s Laws: KCL (current law), KVL (voltage law)
• Analysis
  – DC sources and resistors
  – Nodal analysis
  – Mesh analysis
  – Opamp circuits
• Useful tools
  – Series/parallel combinations
  – Superposition
  – Thevenin/Norton equivalent circuits
  – Source transformation

Electric Charge

• An electrical property of materials measured in coulombs (C) and is denoted by the symbol q

- Charge of an electron (denoted by e) is negative and of magnitude $1.6 \times 10^{-19}$ C ($|q_e| = 1.6 \times 10^{-19}$ C)
  - $-1$ C of charge = charge of $6.25 \times 10^{18}$ electrons ($1/1.6 \times 10^{-19}$)
• Charge of a proton is positive of value $1.6 \times 10^{-19}$ C
• Like charges repel, charges of opposite polarity attract
• Law of conservation of charge: the net charge in a closed region can neither be created or destroyed (only transferred)
Conductors/Insulators

- In a metal or conducting material electrons are free to move around under the application of an electric field
  - Aluminum, copper, gold, silver
  - Good conductor of electricity
- In an insulator all electrons are tightly bound to the nucleus and are not free to move
  - Plastic, glass, rubber
  - Do not conduct electricity

Current

- The flow of charge (time rate of change) is known as electric current
  - Symbol I or i
  - Units of current are amperes (A)
    - 1 A = 1 C/1 s (rate of flow of one coulomb of charge per second)
- Conventional current flow is the movement of positive charge (i.e., opposite to the flow of electrons)
- All circuit elements are electrically neutral, i.e., $i_{in} = i_{out}$

- Direct Current (dc) – current that is constant with time
- Alternating Current (ac) – current varies as a sinusoid with time
Current and Charge

• Typical scales for current:
  – integrated circuit (IC, chip) μA to A
  – flashlight 100 mA - 1A
  – space heater 10A (110VAC outlets are 15A - 20A rating)
  – automobile starter motor 100 - 400A
  – power distribution 200A - 1 kA
  – lightning bolt > 10 kA

• Charge transferred between time $t_0$ and $t$
  $$q(t) = \int_{t_0}^{t} i(t) dt$$  (C)

Water Flow Analogy

• Consider the flow of water in a pipe
  – flow of water $\Leftrightarrow$ flow of charge
  – flow rate $\Leftrightarrow$ current
Electric Circuit

- Wires in electric circuits are similar to pipes that carry water.
Ex1: How much charge is associated with 5000 electrons?

Charge on an electron = \(-1.6 \times 10^{-19}\) C

\[5000 \text{ electrons} = 5000 \times (-1.6 \times 10^{-19}) \text{ C} = -8 \times 10^{-16} \text{ C}\]

Ex2: Find if charge flow is given by

\[q(t) = 5t^2 + 4t - 3 \text{ C}\]

\[i = \frac{dq}{dt} = 10t + 4 \text{ A}\]

\[i(t = 1) = 10 \times 1 + 4 = 14 \text{ A}\]

Ex 3:

For \(0 < t \leq 2\) ms

\[i(t) = \frac{80 \text{ mA}}{2 \text{ ms}} = 40 \text{ A}\]

For \(8 < t \leq 12\) ms

\[i(t) = -\frac{80}{4} = -20 \text{ A}\]

Ex 4: Total charge flow for \(0 < t < 2\) s when

\[i(t) = e^{-2t} \text{ mA}\]

\[q(t) = \int_{t_0}^{t} i(t) \, dt = \int_{0}^{2} e^{-2t} \, dt \text{ mC}\]

\[= 0.49 \times 10^{-3} \text{ C} = 490 \mu\text{C}\]