Intro to Applied Technical Mathematics

Part 14a of
“Electronics and Telecommunications”
A Fairfield University E-Course
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Section 14 Schedule

Session 14a	**11/19**	**Intro to Applied Technical Mathematics**	**Notes: Binary/Octal/Hex, Powers of 10, Basic Algebra**
Session 14b	11/24	DC & AC Motors	Elect1-7: pp. 7-39: 7-69, pp. 7-89: 7-117
Session 14c	11/26	Levers/gears, Torque/HP/RPM	
Quiz 14 Review (Quiz 14 due 12/07)	12/01		
Quiz 14 Results	12/08		
MT8 (Sat,Cheshire)	**12/13**		
MT8 Results	12/15		

Section 14: Applied Technical Mathematics

- Math review
  - Binary numbers (Hex and Octal)
  - Powers of ten
  - Working with equations
- DC & AC Motors and Generators
  - Simple relationships and vocabulary
- Levers and Gears
  - Relating linear force and motion to rotational torque and motion
  - $F=M*A$ vs $T=J*\alpha$
- Torque, RPM and Horsepower
  - Simple relationships and vocabulary

Solving Equations

- Test tube example (pp. 123-124)
  - How many test tubes can be filled to 0.6 milliliters (ml) from a container which contains 60 ml.

$$\boxed{n * 0.6 = 60}$$

$$\boxed{n * \frac{3}{5} = 60}$$

$$\boxed{n * \frac{3}{5} * \frac{5}{3} = 60 * \frac{5}{3}}$$

$$\boxed{n = \frac{60*5}{3} = 20 * 5 = 100}$$

Algebraic Order

- In mixed operations follow the algebraic order:
  - Multiply/divide
  - Add/subtract
- Alternately, use parenthesis to make things clear

$$\boxed{\frac{2}{3} * 24 - 11\frac{1}{2} = 16 - 11\frac{1}{2} = 15\frac{2}{2} - 11\frac{1}{2} = 4\frac{1}{2}}$$

Number Systems

- Decimal Numbers (we have 10 fingers)
  - $2705 = 2*10^3 + 7*10^2 + 0*10^1 + 5*10^0$
  - Zero is a place holder (an Arab invention)
  - Replaced Roman Numerals (MCMXVIII=1943)
- Binary Numbers
  - Based on powers of 2 (the “base” or “radix”)
  - $1010 = 1*2^3 + 0*2^2 + 1*2^1 + 0*2^0 = 10$ decimal
  - k bits can count up to $2^k – 1$ (2^k values including zero)
    - 8-bits ⇨ 256 values, 16-bits ⇨ 65536 values (64k binary)
    - 10-bits ⇨ 1024 values (1k binary)
    - 20-bits ⇨ 1,048,576 values (1 meg binary)
  - Well suited for our 2-valued digital logic (computers)

Adding Binary Numbers

- Let's do an example:
  17 = 00010001 (eight bits)
  11 = 00001011
  28 = 00011100 (watch out for "carries")
  16 + 8 + 4
- Another example
  17 = 00010001
  -5 = 11111011 (two's complement again)
  12 = 00001100 (the "overflow" is ignored)
  8 + 4
- Note that subtraction is done by adding the twos complement of the "subtrahend"

Octal and Hexadecimal

- Octal – 3 bits at a time
  - 0 to 7 (eight possible values per digit)
  - 374 octal = 3*64+7*8+4*1 = 192+56+4 = 252 decimal
    011 111 100 binary =
    0*256+1*128+1*64+1*32+1*16+1*8+1*4+0*2+0*1
    = 252 decimal
- Hexadecimal – 4 bits at a time
  - 0 to 9, A to F (16 possible values per digit)
  - 0FC Hex = 0*256+15*16+12*1 = 240+12
    (0000 1111 1100 binary)
    = 252 decimal

Powers of 10, Scientific Notation

- $1.5372 * 10^3 = 1537.2$
  - Multiplying by 1000
  - Move the decimal point 3 spaces to the right
- $672.57 * 10^{-3} = 0.67257$
  - Dividing by 1000
  - Move the decimal point 3 spaces to the left

kilo (k)	10^3		milli (m)	10^{-3}
Mega (M)	10^6		micro (μ)	10^{-6}
Giga (G)	10^9		nano (n)	10^{-9}
			pico (ρ)	10^{-12}

Equations

- Term1 = Term2
  - Add (or subtract) the same number to both sides
  - Multiply (or divide) both sides by the same number (except zero)
  - Square (or take the square root of) both sides
  - Use the same function on both side (sine, arccos, log …)
- 3*y = 6*x + 3 and x = 2
  first divide both sides by 3
  y = 2*x +1
  now substitute for x
  y = 2*2 + 1 = 5
  (you could have done this in the other order)

Again

- $3*y = 6*x + 3$ and $x = 2$
  first substitute for x
  $3*y = 6*2 + 3$ or
  $3*y = 15$
  now divide both sides by 3
  $y = 5$
  (the same answer)

Two Equations and Two Unknowns

- It turns out that you can add equations
  $2x + 3y = 7,\ 3x - 2y = 4$
  multiply the first equation by 2 and the second by 3
  $4x + 6y = 14$
  $9x - 6y = 12$ now add
  $13x = 26$ or $\mathbf{x = 2}$
  now substitute this value back into the first equation
  $2*2 + 3y = 7$
  $4 + 3y = 7$
  $3y = 7 - 4 = 3$ or $\mathbf{y = 1}$
  We'll do more examples later in this section

FOILing

- Multiplying two expressions
  $(a+b)*(c+d) = a*c + b*c + a*d + b*d$
  FOIL – First, Inner, Outer, Last
- $(x+5)*(2x+2) = 2x^2+10x+2x+10 =$
  $\mathbf{2x^2+12x+10}$
- This is a second-order polynomial in powers of x
  - It is non-linear (linear only has x^1 and constant terms)
  - Second order polynomials are called “quadradic”
  - $(x+5)$ and $(2x+2)$ are its “factors”
- Some people get good at “factoring” polynomials
  (also called unFOILing)

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