EE 201.3 (Section 03)

(Instructor: Denard Lynch)

Final Examination

Saturday, December 7, 2002

2:00 PM

Time Allowed: 3 Hours

Materials allowed: One 8½" X 11" sheet of notes,
Calculators

Instructions:

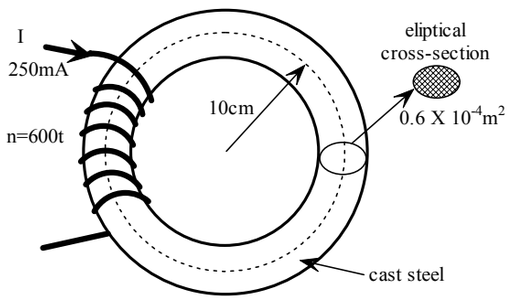
- **Answer all questions in the space provided (use page backs for rough work if necessary)**
- **State your assumptions; show all relevant work. Box, circle or otherwise highlight your answers.**
- **Put your <u>name</u> and <u>student number</u> on the cover page; put *only* your <u>student number</u> on all remaining pages.**
- **Weighting for each question is indicated in the left margin (Total marks:100)**

1	2	3	4	5		Total
/11	/11	/12	/14	/11		/60

[1] **Name:**_____

Student Number:_____

1) A circular magnetic core made of sheet steel has an average radius of 10cm and an elliptical cross section of 6cm^2. It is energized by 250mA flowing through a 600 turn coil as shown in the sketch. (Note: Some B-H data can be found on the charts on the last page.)



a) What is the direction of flux in the core (***clock-wise*** or ***counterclockwise***)?

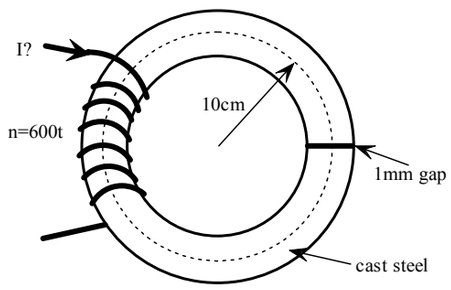
[3]

b) What is the flux density, ***B***?

c) What is the inductance of the coil at this level of flux?

[2]

d) If a 1mm air gap is cut in the core (as shown), what value of current is required to maintain the total flux level in the core at 0.02mWb?

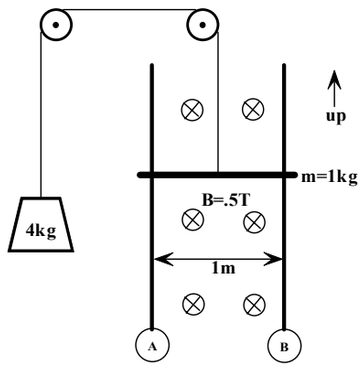


(Note: Use the following table to assist with your calculations)

Leg	Φ (Wb)	A (m^2)	B (T)	L (m)	H (At/m)	Hl (At)

2) Write Ohm's Law for magnetic circuits in terms of the magnetomotive force, ***F,*** reluctance, ***R,*** and flux, ***Φ***.

3) A bar & rail system is against wall so it is positioned vertically as shown in the diagram at right. The rails are 1m apart and a magnetic field of 0.5T, directed into the wall, exists everywhere of concern. The mass of the bar is 1kg and the mass of the weight is 4kg. The coefficient of friction, μ=0.2 . Assume that i) the bar maintains adequate contact with the rails for resistance-less conduction to take place, and ii) that the rails are long enough to reach a steady state condition where applicable.



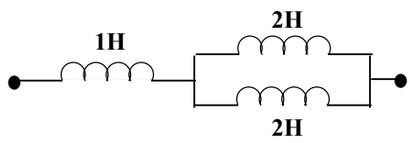
a) Assuming the bar is stationary and a battery with a 10Ω series resistance is connected to the terminals (A and B) What value of ***voltage*** will keep the system from moving? To *which terminal*, ***A*** or ***B***, should the positive terminal of the battery be connected?

b) A 24V battery with a 1Ω series resistance is connected between the rails (A positive) and the system is allowed to reach steady state. Will the Bar & rail system be acting as a motor or a generator?

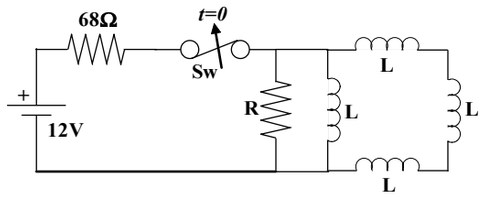
c) If an alternating current source of $85\sin 377t$A is connected to the rails (B positive), which way will the *weight* move (***up*** or ***down***)?

d) Assume a 1Ω resistor is connected between the rail terminals, A and B, and the system starts at rest at time, t=0. Determine the ***velocity of the bar*** (magnitude and direction) as a function of *time*.

4) What is the total inductance of the circuit at right?



5) The circuit shown in the sketch has a 12V DC battery supplying current through a switch to the R-L circuit as shown. Each inductor is 10mH and can be considered ideal (i.e. no internal resistance).



b) Assuming the switch is closed and the circuit has reached steady-state, how much ***power*** is being dissipated by the 68Ω resistor?

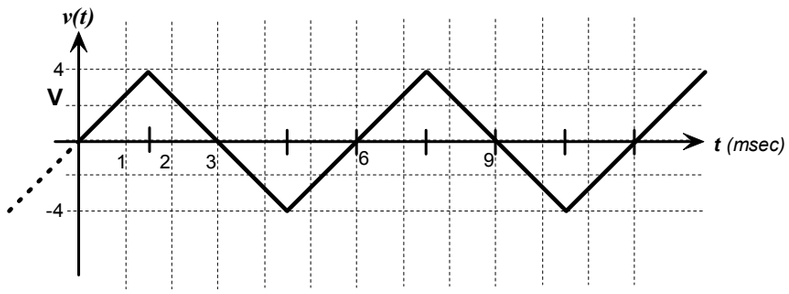
c) What is the maximum ***current*** the resistor, R, must conduct if the switch is opened?

d) Assuming the decaying time constant, $\tau = 0.1$sec, how long after the switch is opened will the ***energy*** stored in the inductors fall to ½ of its maximum?

e) ***After*** the switch is opened, how much ***heat*** will be transferred to the resistor, ***R***?

[2]

6) Given the $4V_{0\text{-}P}$ waveform shown in the sketch, determine the *expression* for a sinusoidal waveform that will have the same ***heating*** effect. Give your answer in both ***phasor*** (RMS) and ***time-varying*** ($A\sin\omega t+\theta$) notation. (Note: the RMS value of a sinusoidal waveform is $V_{Max}/\sqrt{2}$; use calculus to determine all other values.)



[1]

7) What is the ***average*** value of the waveform $13.33\sin(377t + 45^o)$V? _____

7) A manufacturing facility is served by a single-phase, 600Volt AC, 60Hz supply. At present, the building has the following loads:
   - 30 X 200W incandescent lights over the shop floor (F_P = 1)
   - 80 X 80W incandescent lights (F_P = .88 lagging)
   - 2 - 5hp motors; one fully loaded, the other 60% loaded. Both have η=.87 and F_P=.63 lagging. (Note: 1hp = 746W)

   When the building was originally set up, a 80μF capacitor was installed to improve the power factor for the anticipated load. The building load has changed somewhat since the original installation.

[1]

a) Find the real, reactive and apparent power for the total building <u>*excluding*</u> the power correcting element.

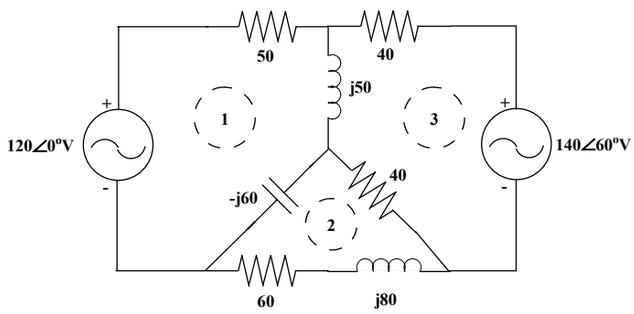
b) Determine the current power factor for the building including the capacitive element.

The shop manager wants to add a 10hp motor (fully loaded) to run additional machinery. It has an efficiency, η=.93 and a lagging F_P=.6 .

c) What power correction element would be needed to *exactly* compensate for the 10hp motor (only)?

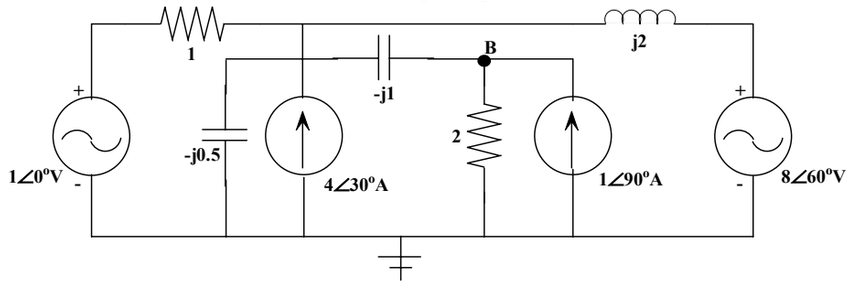
d) What *additional* power correction element would be needed to correct the power factor for the whole building (including the new 10hp motor) to 0.9 lagging?

8) Write a series of equation to solve for the loop currents for the network shown at right. (Note: not necessary to solve, but set up in matrix formation)



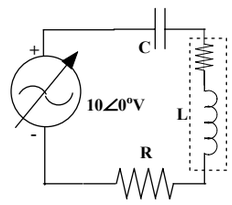
[1]

9) In the network shown below, find the voltage at point B.



10) If $Z_1 = 10\angle 45^\circ\Omega$and $Z_2 = 10\angle -45^\circ\Omega$, Z_1Z_2 = _____.

11) Design a series resonant circuit given the following:



- it will be connected to a $10\angle 0^{o}$V source (constant at all frequencies),
- you are given a 10mH, "real" inductor with a Q=10 @1000Hz,
- the impedance must be a minimum at 2.3kHz,
- at 3kHz, the circuit will generate ½ the amount of heat it can generate at its maximum.

[1]

a) find the value of *capacitor* needed to meet these conditions

b) What value of *resistor*, ***R*** is needed to complete the circuit?

c) What is the Quality Factor, ***Q***, of this circuit?

d) What are the *peak* voltage and current ratings for the inductor and capacitor?

e) What wattage rating of resistor is required (e.g. what is the maximum amount of heat that must be dissipated by R?)

f) What value of inductance, when connected in parallel with the 10mH inductor will change the resonant frequency to ½ of its original value?

12) the complex value (2 -j2)Ω in polar form is: _____.

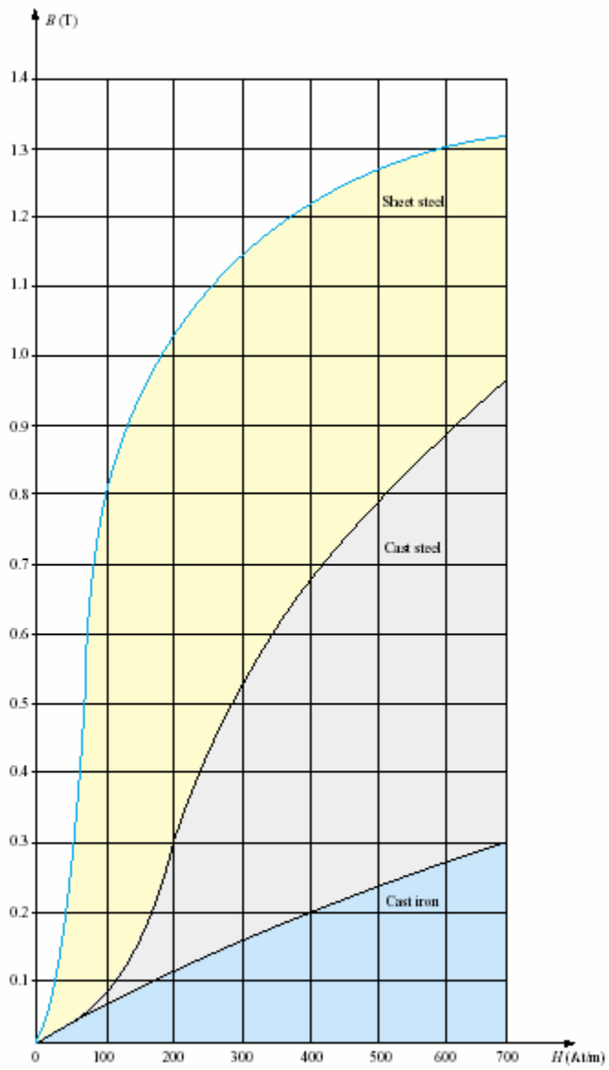


FIG. 11.24
Expanded view of Fig. 11.23 for the low magnetizing force region.

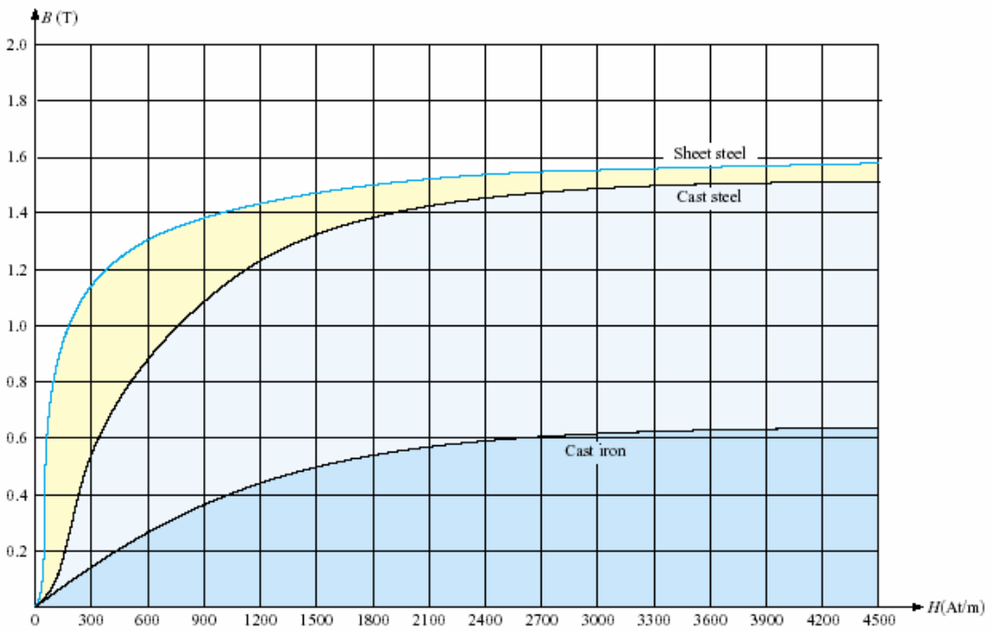


FIG. 11.23
Normal magnetization curve for three ferromagnetic materials.

from: Boylestad's 2nd Canadian Edition