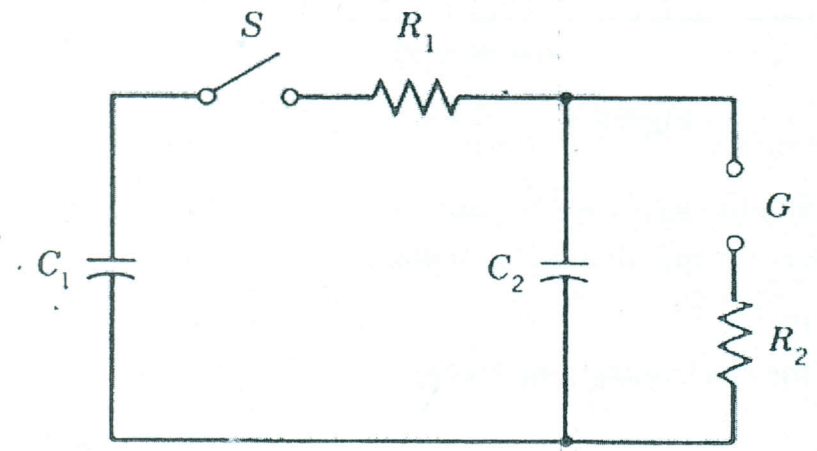
University of El-Mansoura
Department of Electrical Engineering
Elective Course: Electromagnetic Transients in Power Systems
Final Exam January 2013 Time Allowed: 3 Hours

ATTEMT ALL QUESTIONS (Grades are equally weighted). 1/2

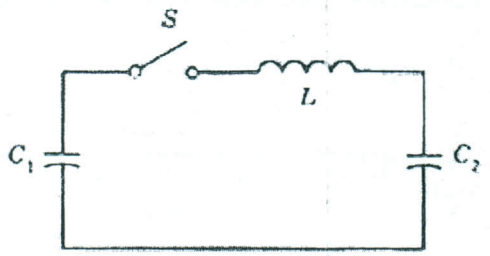
1. Initially, the capacitor C_1 in Figure 1 is charged to 100 kV and C_2 is uncharged. The switch S is closed and 40 μs later the gap G sparks over. Find:
   (a) The current in R_2 and the voltage on C_1 immediately after sparkover.
   (b) The energy transferred to C_2 from C_1 at the time of gap sparkover. And how much energy spent in R_1.



$C_1 = 5\ \mu F, \quad C_2 = 0.5\ \mu F$
$R_1 = 100\ \Omega, \ R_2 = 1000\ \Omega$

Figure 1

2. Derive from first principles the expressions for the voltages $v_{c1}(t)$, $v_{c2}(t)$ that will appear on C_1 and C_2, respectively, and the current i(t) that flows in L, after the switch is closed in the circuit shown in Figure 2. Sketch $v_{c1}(t)$, and $v_{c2}(t)$, and find the maximum voltage attained by C_2. .



$C_1 = 5\ \mu F, \ C_2 = 0.5\ \mu F$
$L = 10$ mH
$V_1(0) = 100$ kV, $V_2(0) = -50$ kV

Figure 2

P.T.O.

3. Figure 3 shows two capacitor banks, C_1, 5 MVAR and C_2, 3 MVAR on 13.8 kV base. The source has a short circuit rating of 20 kA rms at 13.8 kV. The inductance of the loop between C_1 and C_2, represented by L_2 is 30 μH.
Calculate the peak transient voltage that will appear on C_1 and C_2 ,respectively, and the peak transient current that will flow in L_2, if the switch is closed at the peak voltage cycle. Point out any assumptions you make.

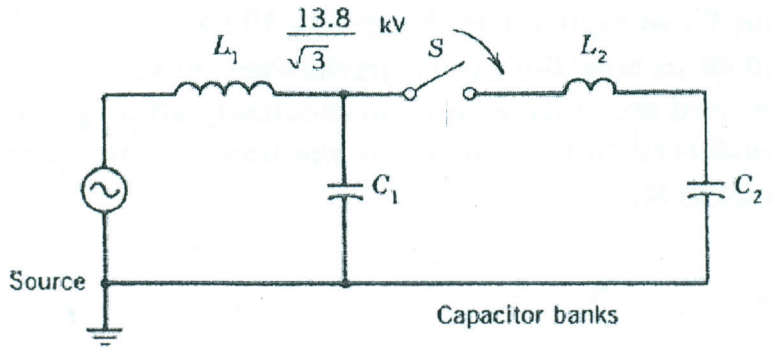


Figure 3

4. The following characteristics apply for thr line cable feeder shown in Fig. 4:
Overhead line: Characteristic impedance Z_{line} = 400 Ω

Line length L_{line} = 3000 m

Propagation velocity of the electromagnetic waves

v_{line} = 300 000 km/s

Cable Characteristic impedance Z_{cable} = 40 Ω

Cable length L_{cable} = 100 m

Propagation velocity of the electromagnetic waves

v_{cable} = 100 000 km/s

The circuit breaker closes at t = 0 for a unit-step input voltage. Sketch the voltage profile at the line-cable junction for t = 15 μs

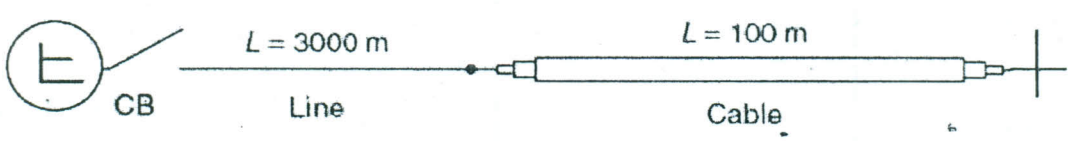


Figure 4