BITS PILANI K. K. BIRLA GOA CAMPUS

SEMESTER-II, 2022-2023

POWER ELECTRONICS (MIDSEM) EEE_INSTR F342 (Part-A)

Date-15/03/2023 Total Marks: 10×3M=30 Duration: 30 min

[Take necessary assumptions with proper justifications whenever required]

[Write your answers up to four decimal places]

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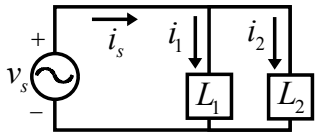
1. Two loads L_1 and L_2 are connected in parallel to each other as shown below:



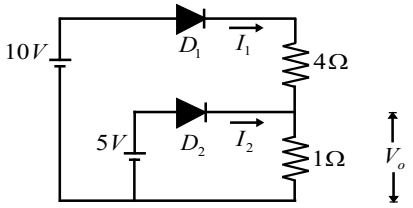
The current expression of each load is given as:

$i_1 = 30\ Sin\ 20t - 15 \sin 40t + 8\ sin\ 60t - 6\ sin\ 80t$

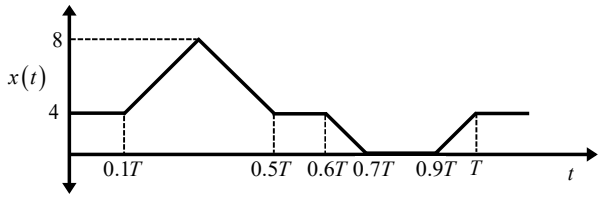
$i_2 = 8\ cos\ 20t + 4 \sin(40t + 30°) + 2\ sin\ 80t$

Find the RMS value of the source current (Is_rms, in Amps). **[3]**

2. Find the source current THD given in Question No-1 (THD, in %). **[3]**
3. Find the source power factor (pf_source) in Question No-1, if the source voltage expression given in Question No-1 is $v_s = 230\ Sin\ 20t$. **[3]**
4. A resistive switching circuit is connected to a source of 400 V. It is operated at a switching frequency of 100 kHz. Turn-on time of the Thyristor is 200 ns. A small leakage current of 0.8 A still flow during the off state of the Thyristor. Find the average power loss (P_on, in W) during the turn on process of the Thyristor if R = 4 Ohm. **[3]**
5. A resistive load of 1000 Ohm is connected to a single-phase supply of 230 V, 50 Hz, through a half wave diode rectifier. Calculate the magnitude value of the average voltage across the diode (V_do, in Volts) if the diode has an internal resistance of 20 Ohms. **[3]**
6. Find the current through diode D_2 (I_2, in Amps) in the circuit given below **[3]**



7. The ratings of two heaters are 230 V, 1 kW and 230 V, 1.5 kW respectively. The two heaters are connected in parallel to each other and the combination is supplied by a single-phase AC supply of 230 V, 50 Hz through a diode. Calculate the power delivered to the two heaters (P_heat, in kW). **[3]**
8. From the wave form of $x(t)$ find out the dc component a_0 in the Fourier series expansion of $x(t)$ which is represented as: **[3]**



9. The minimum value of the gate triggering voltage and current of a Thyristor are 2 V and 100 mA respectively. A resistor of 12 Ohms is connected across the gate-cathode terminals to by-pass thermally generated leakage current. Find the value of resistance (R_s, in Ohm) to be connected in series with the gate circuit in order to ensure turn-on of the Thyristor, if triggering supply voltage is 10 V. **[3]**
10. A three-phase full-controlled rectifier feeds power to a resistive load of 10 Ohms. For a firing angle of 30 degrees, the load takes 5 kW power. Find the magnitude of per phase input supply voltage (V_ph, in Volts). The load current is assumed to be constant. **[3]**

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SEMESTER-II, 2022-2023

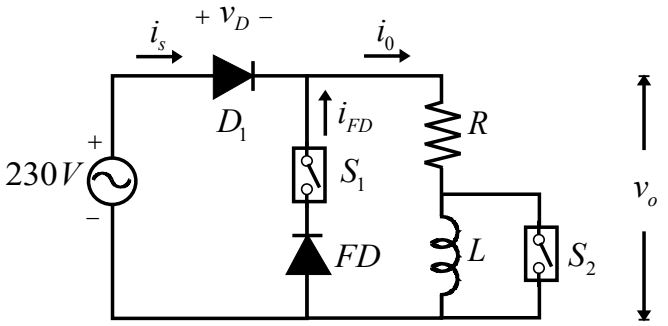
POWER ELECTRONICS (MIDSEM) EEE_INSTR F342 (Part-B)

Date-15/03/2023 Total Marks: 15×3M=45 Duration: 60 min

[Take necessary assumptions with proper justifications whenever required]

[Write your answers up to four decimal places; Prepare an index at the first page; Answers should be according to the order of the questions]

Q1. A single-phase 50 Hz half wave rectifier circuit is shown below:



The switch S_1 is opened and switch S_2 is closed.

(a) Draw the output voltage waveform of V_0 for two complete cycles and write an expression of V_0 to define it. **[1]**

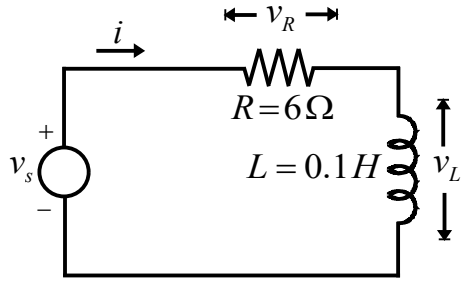
(b) Derive the values of Fourier series coefficients a_0, a_k and b_k for the output voltage waveform of V_0. Here, a_k and b_k are the kth coefficients of the cosine and the sine terms in the Fourier series. **[2+3+3]**

Now, the switch S_1 is closed and switch S_2 is opened simultaneously. Consider the extinction angle (β) is greater than π radian.

(c) Derive the RMS value of output voltage in terms of the source voltage. **[2]**

(d) Draw the waveforms for v_D, i_s, i_{FD} and v_R (Voltage across resistance R) for two complete cycles. **[4]**

Q2. A RL load is connected to a non-sinusoidal voltage source of v_s as shown below:



The expression of the non-sinusoidal source voltage v_s is given as

$$v_s = 63.60 + 100 \text{ Sin } 377\text{t} - 42.40 \cos 754\text{t Volt}$$

Assume the initial current through the inductor is zero.

(a) Find the expression of source current $i(t)$ by deriving the complementary function $i_c(t)$ and the particular integral $i_p(t)$. **[8]**

(b) After some time, the circuit reaches steady state. Now, find the RMS value of Source current (I_rms, in Amps), RMS value of the voltage across resistor (V_R in Volts) and RMS value of the voltage across Inductor (V_L, in Volts). **[3+2+2]**

Q3. A three-phase full wave fully controlled rectifier is supplied from a three-phase source of 415 V, 50 Hz. The load consists of a series combination of resistor with R= 8 Ohm and a large inductance that makes the load current constant. For a firing angle of 30 degrees, Find

(a) Average output voltage (V_o in Volts) and load current (I_o in Amps). **[2+2]**

(b) Average value of Thyristor current (IT_o in Volts) and RMS value of Thyristor current (IT_or in Amps. **[2+2]**

Now, a source inductance of 1.5 mH per phase is inserted. Considering the same load current, find out

(c) The new average output Voltage (V_onew1, in Volts). **[2]**

(d) The commutation angle (mu, in degree). **[2]**

Now, along with the source inductance of 1.5 mH per phase, a source resistance of 0.5 Ohms is also inserted in each phase. Forward voltage drop of 2 V for each and every thyristor is considered. Determine

(e) The new average output voltage (V_onew2 in Volts), considering the same load current. **[3]**

**********Best of Luck**********