BITS, Pilani – Dubai
International Academic City – Dubai
III year EEE/ EIE, II Semester 2011-12 / Comprehensive Exam.
Course Title –Power Electronics(EEE C 461/ INSTR C461) Full Marks--80(Weightage 40%) Duration—3 Hrs. Date-14/06/2012

(1)In context to " TURN-ON Control of BJT Base Drive", derive the expression for $i_B(t)$ using Laplace Transform method (with the relevant circuit diagram), starting from fundamentals. Also calculate the time instant at which the base current ($i_B(t)$) becomes 90% of its initial value.
Given data are: (i) R_1= 4.0 ohm (ii) C_1 =1.0 micro farad (iii) Final value of base current is 60% of its initial value ---------- [7+5 marks]

(2) (a) In context to the Resonant Commutation of Thyristor(see Fig.1), following conditions are given: (i) Initial voltage across capacitor= V_s volts(ii) Initial current through the inductor= I_1 amps. Applying Laplace Transform method, prove that current through the inductor is given as, $i_L(t)= I_1 \cos(\omega_0 t)$-C $V_s \omega_0 \sin(\omega_0 t)$-------where ω_0 represents the resonant frequency in rad./sec. The switch(S) is closed at t=o.

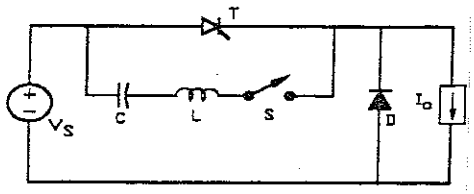

Fig.-1

(b) In connection with Question2(a) , calculate the value of the inductor(L) if the Thyristor has a turn-off time of 20 μ-sec. The given data are: V_s =215 volts, Resonant frequency= 18 KHz. and I_1 =0----------[7+5 marks]

(3) A voltage pulse of height of V_{DD} volts and pulse width of "a" seconds, is injected into the gate of a MOSFET in context to its **"Turn-on" phenomenon**. Following assumptions (changes) and symbols are to be incorporated:
(i)Gate to drain capacitance is realistic and it is equivalent to the parallel combination of ideal capacitor(C_{gd}) and resistor(R_{gd})
(ii) Gate to source capacitance is realistic and it is equivalent to the parallel combination of ideal capacitor(C_{gs}) and resistor(R_{gs})
(iii) $\frac{1}{R} = \frac{1}{R_g} + \frac{1}{R_{gs}} + \frac{1}{R_{gd}}$ (iv) $C = C_{gs} + C_{gd} = \frac{\tau}{R}$

Prove that in Mode-1(using Laplace Transform method),
$v_{gs}(t) = \frac{RV_{DD}}{R_g}\left\{\left(1 - e^{\frac{-t}{\tau}}\right)u(t)\right\} - \frac{RV_{DD}}{R_g}\left\{\left(1 - e^{\frac{-t+a}{\tau}}\right)u(t-a)\right\}$,
where, u(t) and u(t-a) are the Unit Step Function and Shifted Unit Step Function, respectively and $v_{gs}(0) = 0$. ----------[12 marks]

(4) A chopper fed D.C series motor is working under regenerative mode. The machine is having following data:
$V_s = 600\ volts;\ R_a = 0.02\ ohm;$ ---

[P.T.O]

$R_f = 0.03\ ohm$; $K_v = 16.27$ mv/A-rad./sec.; $I_a = 265\ A$(average)
Duty cycle of the chopper=60% and armature current---continuous.

After deriving the relevant formulae and drawing a suitable circuit diagram for the above said drive system, calculate:

(i) Average voltage across chopper(V_{ch})
(ii) Power regenerated to the D.C supply (P_g)
(iii) Equivalent load resistance of the motor acting as generator
(iv) The minimum and maximum permissible braking speeds of the motor(in r.p.m)
(v) Motor speed (in r.p.m)---------- [3+1+9 marks]

(5)(a) Draw the labeled circuit diagram and all relevant waveforms of a single phase full converter (controlled rectifier) with a large inductor as load. What is the purpose of using large inductor as load-----explain.------- [2+2+1 marks]
(b) In context to question 5(a),calculate b_1, b_3, b_5 (Harmonic coefficients) of input current[$i_s(t)$] after deriving the expression for b_n . Given data are: I_a =1.2 amp---fixed value ; Firing angle of Thyristor (α)= 20°.-------- [3+4 marks]

(6) (a) Draw the labeled circuit diagram of a single phase bridge inverter (V.S.I) and draw the waveform of output voltages (v_{ao} , v_{bo} and v_{ab})-- [1+2 marks]

(b) Develop the **"Switching State Table"** of the inverter in question6(a), with conventions given as: upper switch on--- STATE=1; lower switch on--- STATE=0--[3 marks]

(c) Derive the expression for the harmonic coefficient (b_n) of the output voltage (=voltage across load=v_{ab}) of the above-said inverter, starting from fundamentals.-- [4 marks]

(7) (a) Draw the basic circuit diagram(labeled) of a Buck Converter or Boost Conveter------[2 marks]
(b) Draw the equivalent circuits of Mode-1 and Mode-2 of the above-said converter (corresponding to any one of them) and draw the corresponding relevant waveforms.----- [3 marks]
(c) Prove that $\Delta I = \frac{(V_s - V_a)k}{fL}$--------for Buck Converter----[4 marks]

OR

Prove that $\Delta I = \frac{(V_s - V_a)(k-1)}{fL}$------for Boost Converter

BITS, Pilani – Dubai
International Academic City – Dubai
III year EEE/ EIE, II Semester 2011-12 / Test-2 (OPEN BOOK)
Course Title –Power Electronics(EEE C 461/ INSTR C461)
Full Marks – 20(Weightage 20%) Duration—50 min
Date: 20---05—2012(Only Text book and hand written class notes allowed)

(1)In context to the Antisaturation Control Circuit of BJT Base Drive System , calculate: (i) "β"(answer should be in nearest integer value) and (ii)Hence, the collector current magnitude, without clamping. Assume that "β" remains same in the cases of " Without clamping" and " With clamping".
The given data are: V_{CC} =100.0 volts ,V_{d1} =2.1 volts ,V_{d2} = 0.9 volts, V_{BE} =0.7volts, V_B =15.0 volts, R_B =2.5 ohm, R_C =1.5 ohm, Collector current(with clamping) =67 amps-----[5 marks]

(2)Consider a n-channel MOSFET (TURN ON, Modes 1&2) having the following data:
V_{DD} =15.0 volts, I_o =40.0 amps, V_T =3.0 volts, C_{gs}=2600 picofarad , C_{gd}=350 picofarad, g_m =25.0 siemens, R_g =9.0 ohm . Calculate the following: (a) The time instant at which the current through the clamping diode will be 40% of the load current (b) Duration of Mode-1 (c) Duration of Mode-2 [3+3+2 marks]

(3) In context to the Impulse Commutation of a Thyristor(Fig.1), the capacitor is precharged with a voltage of "$-V_c$" volts. "t=0" is counted when the switch(S) is closed. Initial value of current through the inductor is zero. Reverse recovery time (of junction J_2) within the Thyristor structure may be ignored. Prove that the " Turn-off time(t_{off})" of the Thyristor may be expressed as :

$$t_{off} = \sqrt{LC}\ \tan^{-1}\left(\frac{V_c\ \sqrt{C/L}}{I_0}\right).$$ [7M]

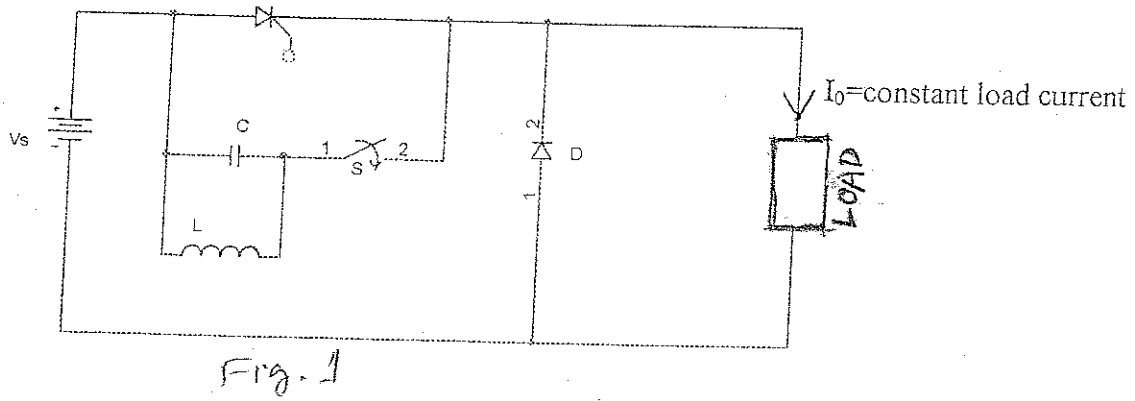

Fig. 1

BITS, Pilani – Dubai
International Academic City – Dubai
III year EEE/ EIE, II Semester 2011-12 / Test-1
Course Title –Power Electronics(EEE C 461/ INSTR C461)
Full Marks – 25 (Weightage 25%) Duration—50 min
Date: 01---04—2012

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(1))(a) Draw the circuit diagram (labeled) of a three phase full-converter using Thyristors, with highly inductive load. Draw also the waveforms of output voltage and input current (phase "a") of this circuit.---[1+2 marks]

(b) With reference to Question 1(a), prove that the r.m.s output voltage(V_{rms}) can be expressed as: $(V_{rms})^2 = 3\,(V_m)^2[(1/2)+\{\{(3\sqrt{3})/(4\pi)\}\,\mathrm{Cos}\,(2\alpha)\}]$.
Hence calculate the value of "α" when following data are given:
V_{rms} =150 volts and v_{an} =Input phase "a" voltage = 170 Sin(ωt)—[4+2 marks]

(2) (a) Draw the circuit diagram (labeled) of a single phase semi-converter using Thyristors, with highly inductive load. Also explain why free-wheeling diode is necessary to be included in such circuit.

(b) Draw the wave form of the current through the free-wheeling diode of the circuit in Question 2(a) and hence derive the expression for the Harmonic Coefficient, "b_n" and "dc component" of this current.-- [1+2+1+4+2]

(3) The output voltage of a single phase full wave bridge rectifier circuit has been expressed as $v_o(t) = (2V_m/\pi) + (4V_m/\pi)\sum [\{(-1)/(n+1)(n-1)\}\,\mathrm{Cos}\,(n\omega t)$]-----for n=2,4,6,8----. The input to the rectifier is a 120 volts(rms), 50 Hz. source. Load resistance is 500 ohms. Design a series inductor, "L" that limits the RMS ripple current, I_{ac} to less than 5% of I_{dc}
----------[6 marks]

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BITS, Pilani – Dubai [Set—A]
International Academic City – Dubai
III year EEE/ EIE, II Semester 2011-12 / Quiz-2/ Set--A
Course Title –Power Electronics(EEE C 461/ INSTR C461)
Full Marks – 14 (Weightage 07%) Duration—20 min
Date: 02---05—2012/ Name---------- Id No.----------

(1)Draw a labeled Two-Transistor Model Diagram of a Thyristor.[3 marks]

(2)Draw a labeled circuit diagram of "ANTISATURATION CONTROL" of BJT Base Drive System.----------[3 marks]

(3)" In context to a Thyristor, Latching Current is of lesser value as compared to that of Holding Current"---Statement—FALSE/TRUE?----[1 mark]

(4)What are the differences between "Resonant Commutation" and " Impulse Commutation" methods of Thyristor?---Mention any two points.-- .[3 marks]

[P.T.O]

Name----------Id No.---------- **[Set-A]**

(5)In the case of Impulse Commutation of Thyristor, given data are :
Device Turn-off time = 20 μ-sec; Constant load current= 50 amp., Initial voltage across Capacitor= -169 volts. Calculate the value of the capacitor (assuming linear charging)--- .[2 marks]

(6) In the case of "Turn-On Control of BJT Base Drive System (given cicuit diagram in Fig.1)", given data are: V_1 =15 volts, V_{BE}=0.7 volts, R_1 =2.5 ohms , R_2 =2.0 ohms. Calculate final value of Base Current.--- .[2 marks]

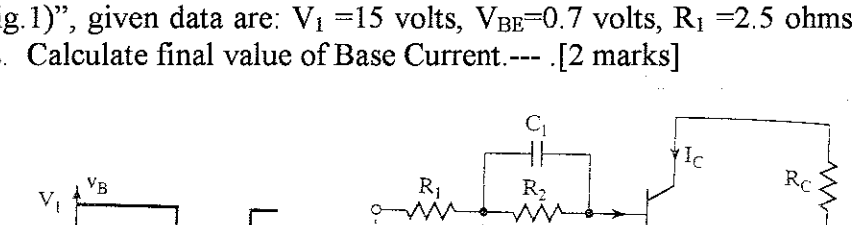

FIGURE 1

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BITS, Pilani – Dubai **[Part—A]**

International Academic City – Dubai

III year EEE/ EIE, II Semester 2011-12 / Quiz-1/ Part--A

Course Title –Power Electronics(EEE C 461/ INSTR C461)

Full Marks – 08 (Weightage 08%) Duration—20 min

Date: 13---03—2012/ Name---------- Id No.----------

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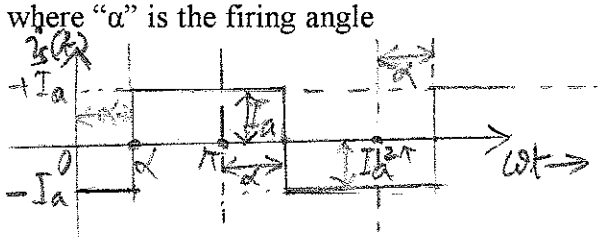
(1) One Harmonic (Fourier) Coefficient is given as $a_n = (4V_m/\pi)\,[(-1)/(n+1)(n-1)]$ The corresponding Power Electronic hardware will be:

(a) A full wave bridge rectifier using Thyristor (b) A half-wave rectifier using Thyristor (c) A full bridge rectifier using Diode-----[1 mark]

(2) With reference to the following waveform for an input current of a power electronic circuit , prove that (after doing Harmonic Analysis) :

$b_n = (4I_a/n\pi)\,\mathrm{Cos}(n\alpha)$----for n= 1,3,5,7----, where "α" is the firing angle of the Thyristor.----------[4 marks]



[P.T.O]

Part-A

Name----------Id No.----------

(3)The output voltage of a particular power electronic converter circuit(with R-L load) has been expressed as $v_o(t)= (2V_m/\pi) + (4V_m/\pi) \sum [(-1)/(n+1) (n-1)] \text{ Cos } (n\omega t)$ -----for n=2,4,6,8----. Prove that the R.M.S value expression of the dominant A.C Component (Harmonic) of the output current will be :

$I_{a.c,dominant} = [(4V_m /\pi)(1/\sqrt{2}) (1/3)][1/ \{ R^2 +4\omega^2L^2\}^{0.5}]$-------[2 marks]

(4) Out of the following, is which expression correct?---for a power electronic system:----------[1 mark]

(a) $PF=(I_{s1}/ I_s) [1/(DPF)]$ (b) $PF=(I_{s1}/ I_s) (DPF)$ (c) $PF=(I_s/ I_{s1}) [1/(DPF)]$

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