BITS,Pilani-Dubai

Comprehensive Examination/2013-14/2nd Semester

Course Title: POWER ELECTRONICS (EEE F342/INSTR F342)

Maximum Marks=60 (Weightage= 30%)/Duration-- 3 hrs.

3rd year(EEE/EIE)/Date of Exam.---01/06/2014

Q. 1(a) In context to " V/f" Control of three phase Induction Motor :

(i) Why is the "V/f" ratio to be maintained constant?------ Give explanation from the view point of mathematical equations. (ii) Draw the block diagram/scheme for the above-said control technique.

(b) A three phase delta connected induction motor has (in per phase):

Stator winding resistance = 1.32 Ω ;Stator winding leakage reactance= Rotor winding leakage reactance referred to stator = 1.46 Ω ; Rotor winding resistance referred to stator = 1.6 Ω ; Supply voltage $= 400\ volts$ per phase; Supply frequency= $50\ Hz.; No.of\ poles = 4; Operating\ Slip = 0.04$; $\frac{V}{f} = \alpha = 0.6$. Calculate the new value of Electromagnetic Torque (in N-m) after applying the " V/f" Control method.------[3+2+6 marks]

Q.2(a) Draw the circuit diagram(labeled) of a single phase Current Source Inverter (C.S.I) using IGBT and explain its functioning and advantages . Also draw the relevant waveforms of output current and gate signals .

OR Q.2(a) Draw and explain the circuit diagram and relevant waveforms of a single phase V.S.I

Q.2(b) Draw only the labeled circuit diagram of a three phase C.S.I using I.G.B.T , with "star" or "delta" connected resistive load (no explanation).---[6+2 marks]

Q.3(a) In connection with the circuit of Impulse Commutation of Thyristor , the capacitor is pre-charged to
"$-160\ "volts\ .C = 6.0\ \mu F\ and\ thyristor\ turn - off\ time\ =$
$20.0\ \mu s\ .Calculate\ the\ value\ of\ the\ constant\ load\ current\ (I_0\ )$, with the switch closed.

Q 3.(b) In context the question 3.(a) ,if a resistor of 5.0 Ω is connected in parallel with the capacitor , calculate after how much time gap with effect from the closing of the switch, the capacitor will charge up to +160 volts. The load current remains same. Mathematical analysis should be done using Laplace Transform.---------- [2+6 marks]----- [P.T.O]

Q.4) 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 $v_{gs}(0) = 0$. ----------[8 marks]

Q.5 In context to a " Single phase full wave thyristorized bridge rectifier with a series combination of resistor, inductor and back e.m.f (battery) load " , draw its labeled circuit diagram waveforms of input voltage and current. Also derive the expression for input current as a function of time (i_s (t)) , after doing its Harmonic Analysis . The final expression must involve the firing angle (α) of the thyristor and the load current, I_a which is assumed to be constant.----[2+1+7 marks]

Q.(6) In context to "TURN-ON Control of B.J.T Base Drive", draw the relevant circuit diagram(labeled) and derive , in detail the expression for the charging time constant of the capacitor, using the method of Laplace Transform . Calculate this time –constant subject to: (i) R_1 =4.0 Ω ; R_2 =2.66 Ω ; C_1 =1.0 μF (ii) The capacitor is initially uncharged.---[1+6+2 marks]

Q.(7) Draw and explain the structural diagram and equivalent circuit of I.G.B.T

OR

Q.(7) Draw and explain the circuit diagram and relevant waveforms of a D.C-D.C Boost Converter using Chopper.---[6 marks]

BITS, Pilani – Dubai
International Academic City – Dubai
III year EEE/ EIE, II Semester 2013-14 / Test-2 (OPEN BOOK)
Course Title –Power Electronics(EEE F342/ INSTR F342)
Full Marks – 20(Weightage 10%) Duration—50 min
Date: 10---04—2014(Only Text book and hand written class notes allowed)

---

(1)The parameters of a UJT (Uni-junction Transistor) are given as:
$V_s = 30\ volts;\ I_p = 10\ \mu A; V_v = 3.5 volts;\ I_v = 10\ mA;\ R_{B2} = 632\Omega$;
$C = 0.5\mu F$. The frequency of oscillation(f) is 60 Hz. The width of the triggering pulse (to be fed to the Gate of any Thyristor) is , $t_g = 40\ \mu s$. Assume,$V_D = 0.5\ volts$ and $V_{BB} = V_s$. Design the values of R and R_{B1} , after verifying the concerned value within limiting values(range) . Also it is given that $T = {}^1/_f = RC \ln \frac{1}{1-\eta}$----[9 marks]

(2) Draw the labeled circuit diagram for three phase thyristorised bridge rectifier with highly inductive load. Also draw the labeled waveforms of input voltages with gate firing instants shown and also draw the output load voltage waveform(labeled).Take $\alpha = \frac{\pi}{3}\ radians.$ --[5 marks]

(3) In context to the Impulse Commutation of a Thyristor(Fig.1), the capacitor is pre-charged 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 :

$t_{off} = \left(\sqrt{LC}\right) \tan^{-1}\left(\frac{V_c \omega_0 C}{I_0}\right)$ [6 marks]

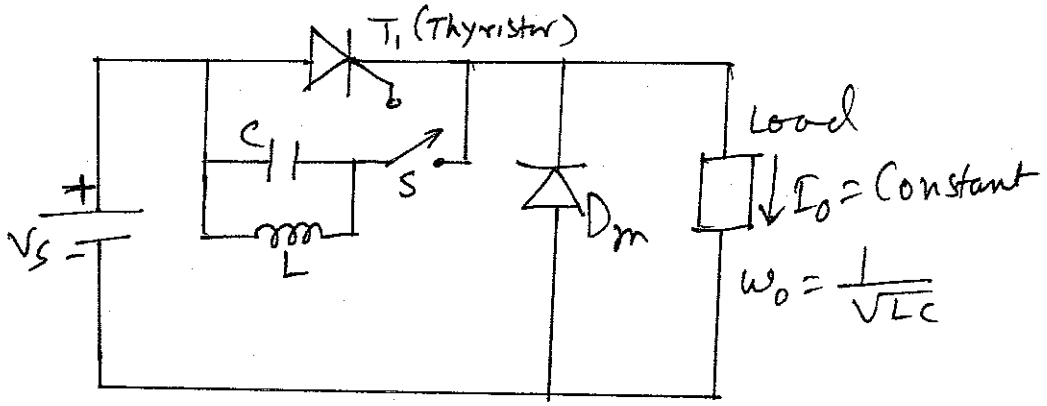

Fig. 1

BITS, Pilani-Dubai Campus

2nd semester, 2013-14

3rd year (EEE &EIE)/ Test-1/ F.M =30 (15%)/ Date of Test-1—27-02-2014

Course Title ---POWER ELECTRONICS

Course Code No.--EEE F342/INSTR F342 / Duration—50 min.

1.)In context to "Single phase half wave uncontrolled rectifier with resistive load", draw the circuit diagram, waveforms of input voltage, output voltage and voltage drop across diode (v_D) . Also , in context to the harmonic analysis of v_D (t), prove that:

$b_n = 0 \; for \; n \neq 1 \; and \; b_n \neq 0 \; for \; n = 1$ and d.c component= $-\frac{V_m}{\pi}$.

The symbols have their usual meanings. ---------[10 marks]

2.) In context to "Single phase full wave uncontrolled bridge rectifier with resistive load ", draw the circuit diagram, waveforms of input voltage and output voltage . Also, in context to the harmonic analysis of output voltage, prove that:

$a_n = \frac{4}{\pi} \frac{(-V_m)}{(n+1)(n-1)}$ -------for even values of "n"

$= 0$ ------- for odd values of "n"

and d.c component= $\frac{2(V_m)}{\pi}$. The symbols have their usual meanings. ----------[10 marks]

(3) In context to "Single phase full wave thyristorized bridge rectifier with a series combination of resistance, inductance and back e.m.f(battery) load ", draw the circuit diagram, waveforms of input voltage ,input current, output voltage and output current. Explain the waveforms also and also derive the expression for the average output d.c voltage as a function of "α"(Firing angle).------[10 marks]

---------- END----------

BITS, Pilani – Dubai
International Academic City – Dubai
III year EEE/ EIE, II Semester 2013-14 / Quiz-2
Course Title –Power Electronics(EEE F342/ INSTR F342)
Full Marks – 10(Weight-age 05%) Duration—20 min
[Date: 08---05—2014] Name/Id No.----------

---

(1)Draw the labeled equivalent circuit of a n-MOSFET (TURN ON /Mode-1) . ..... [2 marks]

(2) For a n-MOSFET(in linear region), write the expression for the drain current (i_D or, I_D) in terms of μ_{ns},C_{ox}, Z, L ,V_{gs} , V_T , V_{ds} and hence derive the expression for g_m . The symbols carry their usual meanings and show all the steps of the derivation. ..... [3 marks]

(3)Consider a n-channel MOSFET (TURN OFF, Mode-1) having the following data:
V_{DD} =15.0 volts, C_{gs}=2600× 10^{-12} Farad , C_{gd}=350× 10^{-12} Farad, R_g =9.0 ohm . Calculate the time instant (in micro-seconds) at which the "Gate-to-Source Voltage" will be 30% of V_{DD}.----------
[3 marks]

(4) " In the TURN-ON / MODE-4 of a n-MOSFET , the diode (D_m) will remain as clamped "---
TRUE /FALSE ? ..... [1 mark]

(5) Draw the labeled graph of " Drain Current(I_D) vs. time" during the Turn-off phenomenon of a n-MOSFET and also show the different modes time duration on the same graph.---[1 mark]