(Confidential)

Ref. No. :

M.E. (Electrical) 2nd Semester Examination, April 2012

Subject : Power Electronics III

Code No. **EE 1014**

Branch: EE

Time : 3 hours

Full Marks : 70

(i) The questions are of equal value. One mark is reserved for neatness and preciseness.

(ii) Answer any ***three*** questions taking ***one question*** from each group

(iii) Use graph papers, if required, to answer any question(s).

Group A

1. (a) How are PWM pulses generated in a TMS320LF407A DSP using 'symmetric' and 'asymmetric' waves? For the symmetric case, show how the contents of the period register and compare register determine the active and inactive pulse times. In this connection, explain what is 'dead band' and how this can be varied in the above DSP.

(b) How many different interrupt priority levels exist in the TMS320LF407A DSP? What are the necessary steps to configure the DSP to accept an interrupt request from a peripheral device?

(c) What are the different memory addressing modes in the TMS320LF407A DSP? How is a data memory address [illegible]ined in the said DSP? Write a small assembly language program to add two arrays (of size 5 each) stored in the same data page, one starting from the 10^{th} memory location and the other from the 20^{th} memory location. Store the sum from the 390^{th} memory location.

(9 + 7 + 7)

2. (a) What is the range of decimal numbers that can be represented by Q2.13 format (for fixed point processors)? Why is 'per unitisation' necessary when using such a processor? If two different variables having different Q-format representations are to be added, what is the procedure to be followed. Explain with an example.

(b) Give a scheme to implement the rotor flux angular position computation for an indirect vector control drive of an induction motor in DSP.

(c) Explain how logic functions are implemented in FPGAs using 'Look up tables' (LUTs)? Show how the function $Z = X.Y + \overline{X}.\overline{Y}$ can be implemented in an FPGA using multiplexers and LUTs. With a simple block diagram, show how a first order linear differential equation can be solved using an FPGA.

(7 + 8 + 8)

Group – B

3. **a)** Why are resonant converters used only in cases when the input side has d.c. source? What is the unique advantage of application of such converters?
b) A resonant buck converter using a MOEFET has $L_S = 2\ \mu H$ and $C_d = 0.01 \mu F$. The input voltage is 20 V. The converter is intended to feed a 12V, 10 W load with zero-current switching (ZCS). Will the given L_S and C_d combination be able to provide resonant action? Determine the switching frequency clearly showing the high and low durations of the switching logic. Draw graphs of the source side current and load voltage waveforms. Make detailed derivations of all the states in which the converter operates after preparing the switching status table of the MOSFET and the load side free-wheeling diode. If the load resistance is changed to 30Ω, what will be new switching frequency? Draw the load voltage profile during the four states.
c) Draw the circuit diagram of a zero-voltage switching (ZVS) buck converter and briefly explain its working.

(3 + 15 + 5)

4. **a)** Draw a block diagram of (i) a stand-alone power system utilising photo-voltaic source and (ii) a grid-interactive photo-voltaic(PV) system . Explain the operation in general and point out what are the relative merits and demerits of the two systems.
b) Draw the typical I-vs-V and Po-vs- V characteristics of a PV array. With the help of the equivalent circuit and otherwise justify why a PV array is considered as a current source rather than a voltage source. What are the effects of the insolation and temperature on the I-vs-V and Po-vs-V characteristics? What are the effects of partial shading on PV arrays?
c) With regard to the issues in 4(b) above draw and justify the two different Power Electronic converters that are to be used for a grid-interactive PV systems.
d) Explain the basic logic of the perturb-observe and the adaptive perturb-observe algorithm used for maximum power point tracking of the dc-dc converter mentioned above. What are the variables to be sensed and what is the quantity to be controlled w.r.t. the converter (devices)?
e) Explain with appropriate circuit diagram and control block diagram, how a standard 3-phase inverter module can be used as a 3-phase interleaved boost chopper sharing one-third current each?

(5+6+3+5+4)

Group-C

5. **(a)** Describe the role of demagnetizing winding in a Forward converter.
(b) State the method of linearizing the control loop around an operating point.
(c) Obtain the transfer function of a forward converter operating in a continuous-conduction mode.Assume turns ratio is 1:1 for simplicity.
(d) What is K-factor and in what way it does help in designing the compensator?

(4+ 4+10+5)

6. **(a)** Explain briefly with the help of phasor diagrams the principle of operation of D-STATCOM.
(b) Why do you need Clarke's transformation and Park's transform to implement the controller?
(c) Why carrier frequency of SPWM is important in designing a D-STATCOM?
(d) State the decoupling method used to simplify the control structure for a three phase PWM rectifier.

(4+ 8+6+5)