M.E. (Electrical)
2nd Semester Examination, April / May 2014
Subject : Power Electronics III

Code No. **EE 1014**
Branch: EE
Full Marks : 70

Time : 3 hours

(i) The questions are of equal value.
(ii) Answer any ***three*** questions taking at least **one** from Group-B.
(iii) Graph papers will be supplied.
(iv) One mark reserved for brief and precise answers.

Group-A

1. (a) Give a schematic of distribution STATCOM.
(b) Give reason why the STATCOM supply end voltage must be greater than the supply voltage for lagging reactive var compensation.
(c) Show that instantaneous active power supplied by the D-STATCOM depends on d-axis STATCOM current.
(d) Develop the voltage equations of the STACOM in d-q reference frame. [5+4+6+8]

2. (a) Give a schematic of a 3-phase Active Front End converter.
(b) What is reason of using PWM rectifier in an Active Front End converter?
(c) Establish the relationship of d-axis current of the converter with dc current at the output.
(d) Give a schematic of a UPQC and identify the different blocks. [5+4+4+10]

3. (a) A DC to DC converter is represented in Fig. 1 with error amplifier and compensator. The open loop gain crossover frequency is to be set at $\omega_{cross} = 10^5 rad/s$ with a phase margin of 30°. The transfer gain of the PWM controller block is 0.34 and the phase shift introduced is zero. At the frequency 10^5 rad/s, the phase angle of the transfer function of the power stage is -110° and the gain is -15dB. It is given that $R_1 = 1k\Omega$. Find the values of other passive components used in the compensator block.

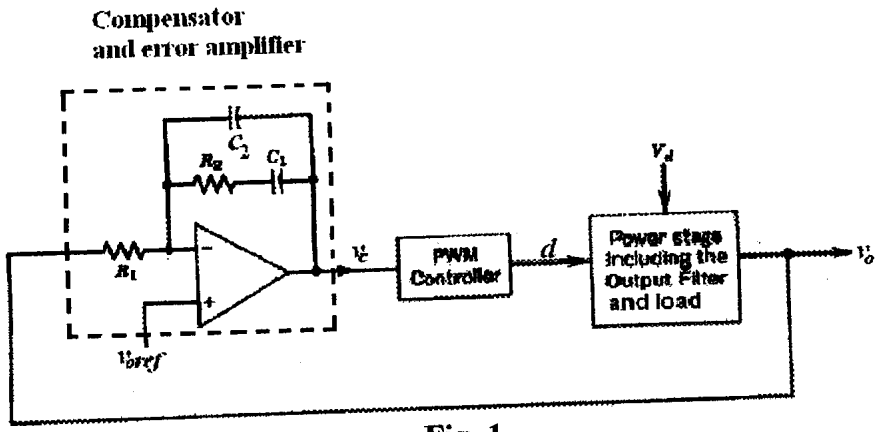

Fig. 1

1/2

(b) Briefly explain the procedure for digitizing the sensed a-phase current using a DSP TMS320LF2407a. The current is to be stored in p.u. value.

[10+13]

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. Draw the equivalent circuit of an array. 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) 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?
d) Explain with appropriate functional and circuit diagram the operation of a simple 3-level inverter. Prepare appropriate tables and identify how many distinct switching states are possible. Draw the space vector diagram for the different switching states and locate the pivot vectors and null vectors.

(5+4+4+10)