MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

SEVENTH SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION
NOV/DEC 2015
SUBJECT: POWER ELECTRONICS (ECE - 403)

TIME: 3 HOURS   **MAX. MARKS: 50**

Instructions to candidates
- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.

1A.   The voltage and current for a device are periodic functions described by

$$v(t) = \begin{cases} 10V & 0 < t < 14ms \\ 0 & 14ms < t < 20ms \end{cases}$$

$$i(t) = \begin{cases} 7A & 0 < t < 6ms \\ -5A & 6ms < t < 10ms \\ 4A & 10ms < t < 20ms \end{cases}$$

Determine (a) Instantaneous power, (b) Average power, and (c) Energy absorbed by the device in each period. Draw the waveforms of instantaneous current, voltage and power.

1B.   With help of cross sectional view and V-I characteristics, explain the working of power MOSFET.

1C.   Explain the concept of latching with the help of two-transistor model of Thyristor.

(5+3+2)

2A.   A single phase full wave fully controlled bridge converter is operated from a 120 V, 60 Hz supply. If the resistance of the load is 10 Ω and the delay angle is $\alpha = \pi/3$, determine (a) Efficiency; (b) Form factor; (c) Ripple factor; (d) Transformer utilization factor; (e) peak inverse voltage of Thyristor.

2B.   A buck converter has $V_S = 20V$, L = 150µH, D = 0.35, R = 20Ω, C = 1000µF and f = 20 kHz. Obtain the values of V_0, average inductor current and maximum inductor current.

2C.   What are the advantages and disadvantages of circulating current in a dual converter? How do you deal with its effects in a dual converter?

(5+3+2)

3A.   With necessary circuit diagram and waveforms, obtain the expressions for V_0, $\Delta V_0 / V_0$, $\Delta V_{c1} / V_0$, $L_{1,min}$ and $L_{2,min}$ for the Cuk converter shown in Figure 3(a).
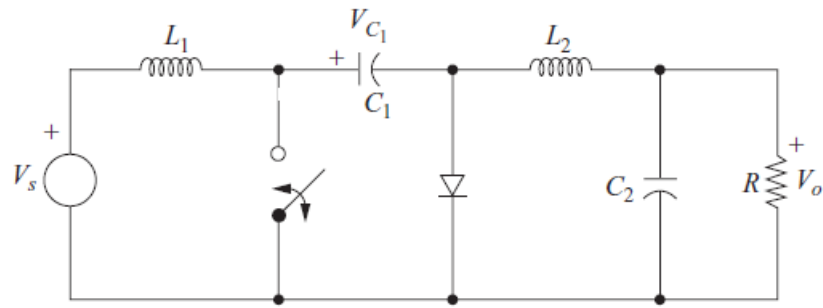
Figure 3(a)

3B. A single phase full-wave controlled rectifier with center-tap transformer is used to supply a heater. Draw the load current and voltage across one thyristor for $\alpha=45^0$. Also obtain the expression for average output voltage.

3C. Design an ac-ac converter which reduces the output frequency as well as the average output voltage to half the original values.

(5+3+2)

4A. For the Forward dc-dc converter shown in Figure 4(a), derive the expression for

(i) Output voltage
(ii) The maximum and minimum current in L_x
(iii) Output voltage ripple
(iv) Peak current in the transformer primary winding

Determine the values of the above parameters if, $V_s = 40V$. $R = 5\Omega$, $L_x = 0.5mH$, $L_m = 4mH$, $C = 100\mu F$, $f = 25kHz$, $N_1/N_2 = 2$, $D = 0.5$.

Also, determine the transformer turns ratio (N_1/N_3) such that magnetizing current is reset to zero during each switching period. Assume all components are ideal

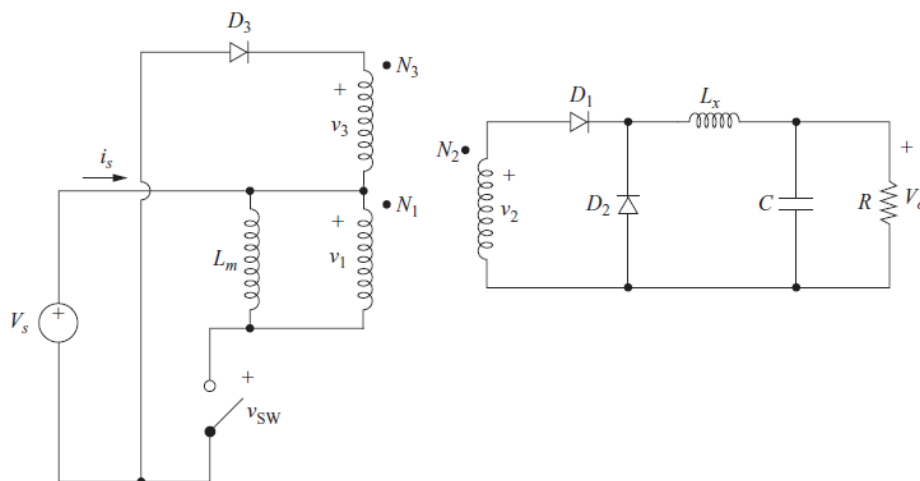
Figure 4(a)

4B. Draw the circuit diagram of current fed DC-DC converter and derive the expression for output voltage.

4C. With the help of necessary waveforms explain the use of feedback diodes in full-bridge inverters.

(5+3+2)

5A. What is the cause of switching losses in a buck converter? Propose a method to eliminate this loss by making the current zero during switching operation. Derive the expression for the output voltage in terms of the time intervals for each circuit condition.

5B. Full-bridge inverter for unipolar PWM is shown in Figure 5(b). Plot bridge voltages v_a, v_b and output voltage for the following switching scheme.

S_1 is on when $v_{sine} > v_{tri}$
S_2 is on when $-v_{sine} \leq v_{tri}$
S_3 is on when $-v_{sine} > v_{tri}$
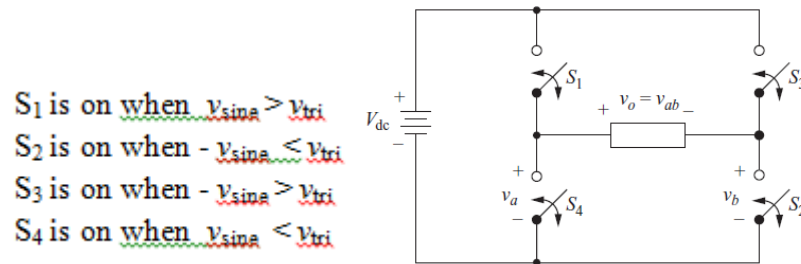S_4 is on when $v_{sine} < v_{tri}$

Figure 5(b)

5C. What are the two advantages of PWM technique over square wave switching scheme in inverters?

(5+3+2)

6A. Draw the circuit diagram of three-phase bridge inverter. Plot (i) phase to phase (V_{bc}) (ii) phase to neutral (V_{bn}, V_{cn}) voltage waveforms in a 3-ϕ inverter with 180° conduction angle. (Note: Just plot waveforms without considering star or delta connected load)

6B. Draw the block diagram and explain the working of UPS.

6C. List various types of power line disturbances

(5+3+2)