INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

AV 322 : POWER ELECTRONICS

QUIZ – I

Time: 60 minutes | *Answer all questions.* | Maximum marks: 30 | Date: 16 Feb 2024

Note : Use linear approximation for all waveforms. Derive the formulae used (except basic formulae).

1. In the buck converter shown in Fig.1, Vs=30V, R=20 Ω. The inductor has a parasitic resistance of 0.02 Ω and the input source has an internal resistance of 0.01 Ω. The ON state voltage drops of the switches S1 and S2 are 0.8V and 0.6V respectively. The switching frequency is 25KHz and the duty ratio (D) of the switch S1 is 0.8.
   a. Evaluate the minimum value of the inductance (L) required to ensure that this converter operates in continuous conduction mode (CCM) at all values of duty ratios.
   b. Evaluate the peak to peak ripple in the inductor current for the value of the inductance (L) determined in 1a. *(9 Marks)*

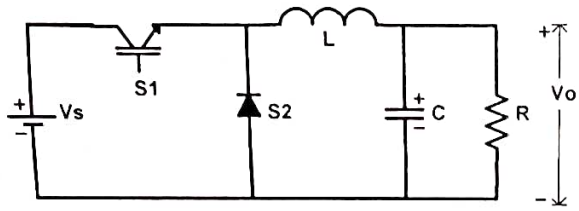

Fig.1

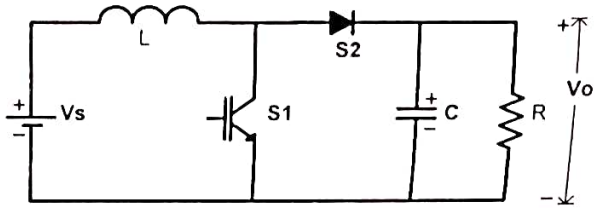

Fig. 2

2. The boost converter shown in Fig.2 is operating in discontinuous conduction mode with a duty ratio of 0.5 and switching frequency of 50 KHz. Assume that all components used in this converter are ideal. Vs=30V, R=50 Ω, L= 40 μH.
   a. Determine the conduction period of the diode.
   b. Sketch the capacitor current waveform and evaluate the capacitance required to limit the peak to peak ripple in the output voltage to 1% of its average value. *(9 Marks)*

3. Fig.3 shows a switched mode power converter with three switches (S1, S2, S3) operating in continuous conduction mode. Vs=24V, L=60μS, C=100μF, R=5Ω. Switching frequency is 50 KHz. Only one switch will be ON at a time and the switches are turned ON sequentially in the order S1-S2-S3, in a switching period. Duty ratios (Ton/Ts) of the switches S1, S2 and S3 are 0.5, 0.3 and 0.2 respectively.
   a. Determine the voltage conversion ratio (Vo/Vs) at steady state, considering it as an ideal converter.
   b. Sketch the waveforms the currents through S1, S2 and S3 at steady state and mark all salient points.
   c. Realise this converter using semiconductor switches with minimum number of controlled switches.

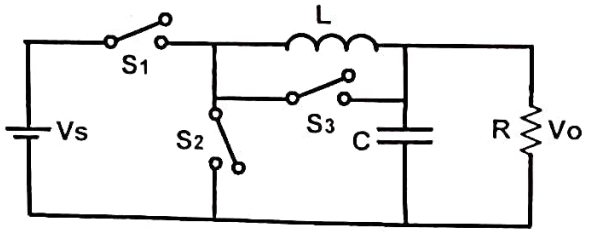

Fig.3

(12 Marks)

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

SIXTH SEMESTER B.TECH ECE – QUIZ-2

AV322 – POWER ELECTRONICS

Time : 60 Minutes | **Answer all questions** | **Maximum marks : 30** | **Date: 01-April-2024**

Note: Use linear approximation for all waveforms.

1. A buck-boost converter with ideal components is shown in Fig.1 Vs=30V, L= 30 μH, output power Po=135W. The switching frequency is 50 KHz and the duty ratio of the switch S1 is 0.6.
   (a) Sketch the waveform of the inductor current and mark all salient points.
   (b) Evaluate the capacitance required to keep the output ripple less than 0.1V.

   (9 marks)

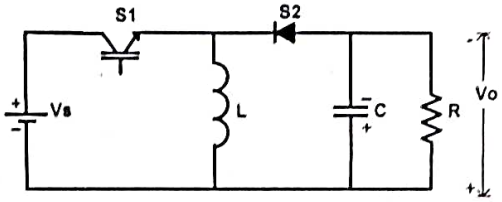

Fig.-1

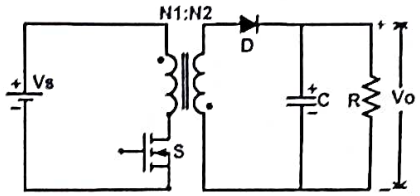

Fig.-2

2. Fig.2 shows a flyback converter with ideal components.. The turns ratio N1:N2 is 1 : 0.125. Vs=100 V, R=1 Ω. The secondary inductance is 5 μH. The capacitance C= 100 μF. Duty ratio D=0.6. The switching frequency is 10 KHz.
   (a) Determine the mode of operation of the converter (discontinues flux mode or continuous flux mode).
   (b) Evaluate the power delivered to the load (R).
   (c) Sketch the waveform of the primary current and mark all salient points.

   (12 Marks)

3. The two-switch forward converter shown in Fig.3 is operating with the following parameters: Input voltage (Vs)=100V, Load resistance R=2 Ω, L=24 μH. Duty ratio D=0.4. Switching frequency is 50KHz. Primary magnetizing inductance is 4mH. The switches S1, S2, D1, D2, D3 and D4 have a voltage drop of 1V in the ON-state. The inductor (L) has a parasitic resistance of 0.02 Ω. Turns-ratio Np:Ns= 1 : 0.25.
   (a) Evaluate efficiency of power conversion.
   (b) Evaluate the conduction loss in diode D2.

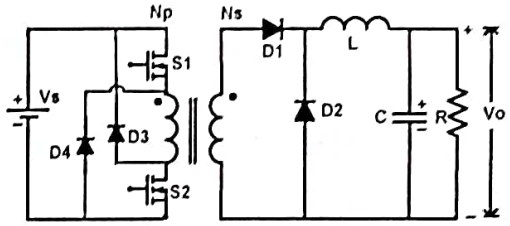

Fig.-3

(9 marks)

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

SIXTH SEMESTER B.TECH ECE - END SEMESTER EXAMINATION – MAY 2024

AV322 – POWER ELECTRONICS

Time : 3 hours | **Answer all questions** | **Maximum marks : 140**

Note: All questions carry equal marks. Use linear approximation for all waveforms.

1. A buck converter operating in continuous conduction mode (CCM) is shown in Fig.1. Vs=30V, R=20 Ω, L=0.4mH. The inductor has a parasitic resistance of 0.02 Ω and the input source has an internal resistance of 0.01 Ω. The ON state voltage drops of the switches S1 and S2 are 0.8V and 0.6V respectively. The switching frequency is 25KHz and the duty ratio (D) of the switch S1 is 0.8.
   (a) Sketch the waveform of the inductor current and mark all salient pints.
   (b) Sketch the waveforms of the current though the switches S1 and S2 and estimate the conduction losses in them.

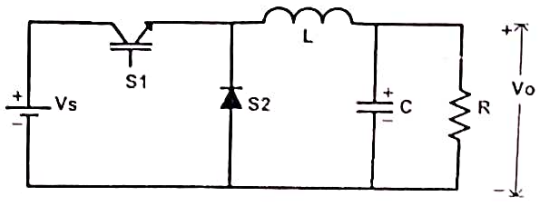

Fig.-1

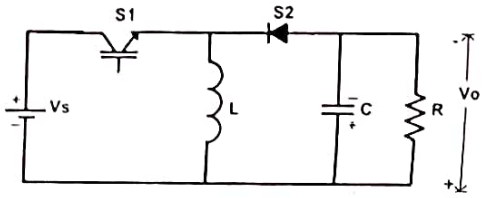

Fig.-2

2. A buck-boost converter with ideal components is shown in Fig.-2. It is operating in discontinuous conduction mode (DCM). Vs=30V, R=50 Ω, L= 50 μH. Duty ratio of the switch S1 D=0.5. Switching frequency Fs= 50 KHz.
   (a) Evaluate the voltage conversion ratio (Vo/Vs).
   (b) Evaluate the capacitance (C) required if the ripple in the output voltage has to be limited to 1% of the average output voltage

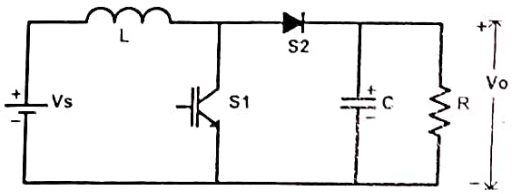

Fig.-3

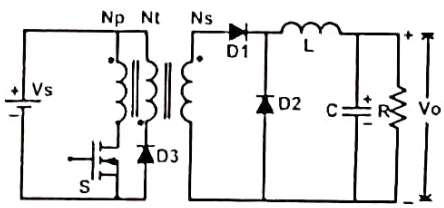

Fig.-4

3. An ideal boost converter is shown in Fig. 3, Vs=10V, R=40 Ω, C=100 μF. The switching frequency is 50 KHz and the duty ratio of the switch S1 is 0.5.
   (a) Evaluate the inductance (L) if the peak to peak ripple in the inductor current is twice the average inductor current.
   (b) For the value of the inductance (L) obtained in 3(a) sketch the capacitor current waveform and evaluate the peak to peak ripple in the output voltage.

4. A forward converter with ideal components, operating on the boundary between CCM and DCM is shown in Fig.4. Input voltage (Vs)=100V, Load resistance R=2Ω. Duty ratio D=0.4. Switching frequency is 50KHz. Primary magnetizing inductance is 4mH. . Turns-ratio Np:Nt:Ns= 1 : 1 : 0.25.
   (a) Sketch the waveform of the primary current and mark all salient points.
   (b) Evaluate the power returned to the source when the MOSFET 'S' is turned OFF.

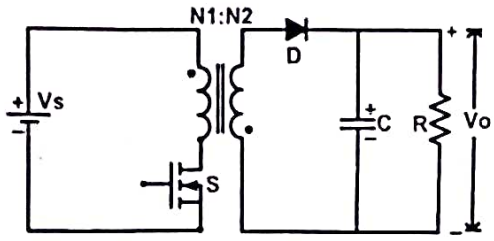

Fig.-5

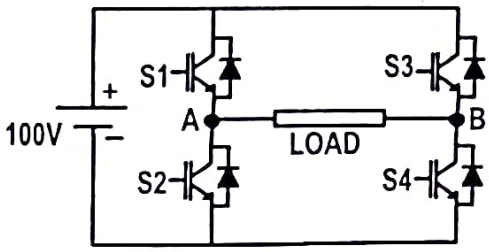

Fig.-6

5. The flyback converter shown in Fig.5 is designed to deliver 20W output at 5V. Vs=120 V, C=600 μF. The turns ratio N1:N2 is 45 : 4. The primary inductance is 20 mH. The switching frequency is 50 KHz. All components are considered to be ideal.
   (a) Determine the operating mode of the converter - continuous flux mode or discontinuous flux mode.
   (b) Evaluate the ratio of the total energy stored in the converter to the energy delivered to the load in a switching period.

6. A pulse width modulated full bridge inverter, employing selective harmonic elimination PWM, is shown in Fig.6. The frequency of the fundamental component of the voltage across the load is 50 Hz. It has to be ensured that even harmonics are absent in the inverter output voltage.
   (a) Evaluate the RMS value of fundamental voltage realizable, if 5^{th} harmonic has to be eliminated from the output voltage.
   (b) Evaluate the pulse width required in a half cycle of the inverter output voltage (quasi square wave) in order to obtain a fundamental voltage of 60 V (RMS), without considering the elimination of any odd harmonic.

7. A two-quadrant DC drive is shown in Fig.7. The motor ratings are: 40HP, 240V, 1200RPM. The efficiency of the motor is 90%. No-load current is 10% of the full load current. The armature resistance of the motor is 0.5 Ω. Vs=300V. The field current is kept constant. The duty ratio of the converter when the motor is running at its rated speed under no-load is 0.8.
   (a) The speed of the motor initially running at 1200RPM at full load has to be reduced to 600RPM by employing regenerative braking. The current during regenerative braking is kept constant at full load current. Evaluate the range of duty ratio variation during the regenerative braking.
   (b) Evaluate the power absorbed by the battery during regenerative braking.

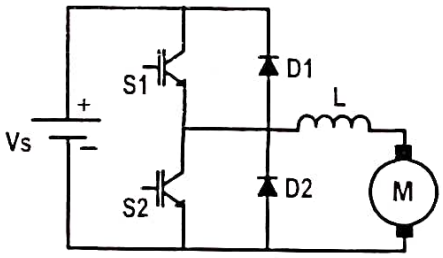

Fig.-7