

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

APPLIED PHYSICS DEPARTMENT

SPH 2105 – ANALOGUE ELECTRONICS

EXAMINATION

BSC HONOURS PART I: APRIL/MAY 2002

DURATION : 3 HOURS

ANSWER **ALL** PARTS OF QUESTION 1 IN SECTION A AND ANY **THREE** QUESTIONS FROM SECTION B. SECTION A CARRIES 40 MARKS AND SECTION B CARRIES 60 MARKS.

SECTION A

1. (a) What are depletion and enhancement modes and FET pinch-off operation? [5]
- (b) Derive an equation for the dc-current of full-wave rectification. Give reasons for choosing centre-tap instead of full-bridge rectifier. [5]
- (c) Determine peak voltage and current for half-wave rectifier with capacitor filter given the following: $R_L = 2000 \Omega$, supply voltage is 200 V at 50 mA and the frequency of 50 Hz with a ripple factor of 2%. [5]
- (d) For a band-pass filter, define Q-factor and show graphically Chebysev low-pass frequency response. [6]
- (e) Give four important characteristics of an operational amplifier and explain virtual ground. [4]
- (f) Explain the following terms: high-frequency range response, low-frequency range response and the Miller effect. [7]
- (g) Define slew rate. If the slew rate is 5 V/(μ s) at a signal frequency of 0.2 MHz, find the maximum sine wave input voltage. [3]
- (h) Derive an equation for the anode current of silicon-controlled rectifier such as thyristor in terms of gain factors and collector-base leakage currents. [5]

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SECTION B

2. (a) What is peak inverse voltage? Write down the differences between a capacitor-filter and an inductor-filter and derive an expression for the ripple factor of L-section filters. [10]
- (b) A load $R_L = 3000 \Omega$ is to be supplied with 150 V at 30 mA for a full-wave rectifier having an L-section filter with $L = 10H$ and $C = 10\mu F$. Design a rectifier-filter combination to meet these specification given that $f = 50$ Hz. [10]
3. (a) (i) Drawing a graph, find the load resistance, R_L given that $V_{CC} = 30$ V, $I_0 = 8$ mA, $I_B = 60 \mu A$ and $V_{CE} = 17.5$ V. Locate the Q-point and also find I_C . [6]
- (ii) Derive expressions for the base voltage V_B and emitter voltage V_E for the bias emitter follower. [6]
- (b) Draw the circuit diagram of the Wien-bridge oscillator and explain its operation. Design a Wien-bridge oscillator which oscillates at 25 kHz frequency. [8]
4. (a) Find an expression for the high-frequency response voltage gain A_{vH} and midrange-frequency current gain A_{iM} for a CE cascade. [16]
- (b) Given that $g_m = 0.020$ mho, $R_L = 1500 \Omega$, $C_{be} = 40$ pF, $C_{bc} = 4$ pF, find the single capacitance connected across the transistor input C_d . [4]
5. (a) Draw a frequency compensation upper Bode plot for -60 dB to 100 dB against frequency in the range of 10 Hz - 100 MHz for 709 operational amplifier drawn in Fig. 1. Show all the features and explain. [10]

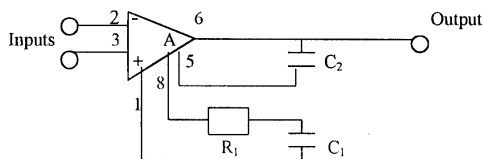


Fig. 1

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- (b) A push-pull amplifier has the supply voltage $V_{CC} = 20V$ and the load resistance $R_L = 10\Omega$. The total number of turns on the primary winding is 100 and the secondary winding has 50 turns. Find:
 - (i) the maximum power that can be delivered to the load and [5]
 - (ii) the power dissipated in each transistor when maximum power is delivered to the load. [5]

6. (a) Design a second-order, voltage controlled voltage source (VCVS), low-pass Butterworth filter with cut-off frequency 2.5 kHz, given that the gain in the pass-band is 2.

Table 1: Second-order low-pass filter Butterworth filter design.

Circuit elements values with resistances in $k\Omega$.

Gain	1	2
R_1	1.42	1.13
R_2	5.40	2.25
R_3	open	6.75
R_4	0	6.75
C_1	$0.33 C$	C

[8]

- (b) In the circuit of Fig. 2, $R_s = 1 k\Omega$ and $R_L = 10 k\Omega$. For the operational amplifier $A = 10^5$, $R_i = 100 k\Omega$ and $R_o = 100 \Omega$. For $v_o = 10 V$, calculate v_s and v_o/v_s . Comment on the result and estimate the input feedback resistance R_{iF} .

[12]

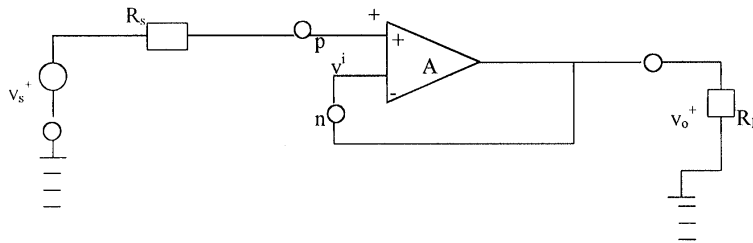


Fig. 2

END OF EXAMINATION

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