UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: March 2022

Module Number: EE5207 **Module Name: Electronic Circuit Design**

[Three Hours]

[Answer **all questions**, each question carries **12.5** marks]

Q1 a) i) Draw the transfer characteristic curve of the Enhancement NMOSFET.

[1.0 Mark]

ii) Using the transfer characteristics briefly explain the amplification capability of the NMOSFET.

[1.0 Mark]

iii) State two differences between a Depletion type NMOSFET and an Enhancement type NMOSFET.

[1.0 Mark]

b) Show that the transconductance (g_m) of an enhancement NMOSFET is given by,

$$g_m = \beta(V_{GS} - V_T)$$

with all the symbols in the formula have the usual meaning.

[2.0 Marks]

c) Figure Q1.1 shows a circuit with an enhancement type NMOSFET which has the following parameters where all the notations have their usual meaning.

$$V_T = 2\ V, \beta = 0.6 \times 10^{-3} A/V^2 \ and\ r_d = 100\ K\Omega$$

i) Show that NMOSFET is operating in the amplification mode.
ii) Calculate the transconductance of the NMOSFET.
iii) Calculate the input resistance of the NMOSFET.
iv) Sketch the small signal AC equivalent circuit.
v) Evaluate the overall voltage gain.

[7.5 Marks]

Q2 a) i) Sketch a practical high pass filter gain response curve ant its phase response curve.

[1.5 Marks]

ii) Compare the Butterworth and Chebyshev high pass filter design techniques.

[1.0 Marks]

b) i) Draw a first order, non-inverting high pass active filter circuit and derive its transfer function.

[1.5 Marks]

ii) Draw a second order non-inverting high-pass filter circuit using the Sallen-Key topology.

[1.5 Marks]

c) Design a practical fifth order unity-gain Butterworth low pass filter with $80KH$ cutoff frequency, using Sallen-Key topology with the following directions.

Directions: The coefficients and the capacitance values for the filters are given in the Table Q2.1. Design each partial filter and cascade them appropriately specifying the relevant capacitor and resistor values. You need to find those resistor and capacitor values using the Table Q2.2 and Q2.3. State any assumptions you make.

[7.0 Marks]

Q3 a) i) What are the three golden rules on PCB design?

[1.5 Marks]

ii) Briefly explain two problems associated with PCB drilling process.

[2.0 Marks]

b) i) Briefly explain what it means by PCB etching.

[1.0 Mark]

ii) By using proper sketches compare the bubble etching and immersion etching.

[2.0 Marks]

iii) Briefly explain what it refers to "under-cut" in etching.

[1.0 Mark]

c) i) Provide a classification for PCBs based on the layers of wiring.

[1.0 Mark]

ii) State two advantages of PCB design.

[1.0 Mark]

iii) With proper sketches, briefly explain two mechanisms to provide the interconnections for double-sided non-plated through hole PCBs.

[2.0 Marks]

iv) Briefly explain what is denoted by "Via" in double sided PCB.

[1.0 Mark]

Q4. a) The circuit shown in Figure Q4.1 is a part of double-sided power supply circuit. The specifications of the circuit are as follows.

$$R = 1.5\ K\Omega \pm 5\%$$
$$V_{in} = 35\ \text{V} \pm 5\%$$
$$V_{out} = 12\ \text{V} \pm 5\%$$

The maximum load current should be kept to 5 mA while the minimum to 0 mA. The tolerance values of R1 and R2 are $\pm$ 5%. The rated power and the rated voltage of the Zenor diode are 0.12 W and 12 V, respectively at no load condition. Determine suitable values for R1 and R2 from E12 series. Clearly state any assumption you make.

[7.5 Marks]

b) Consider the capacitor voltage divider circuit shown in Figure Q4.2. If the input voltage $V_{in} = 50\ V, C_1 = 50\ \mu F$ and the tolerance values for both the capacitors are $\pm 5\%$. Select a suitable value for C_2 from E12 series such that $25 \geq V_{out} \geq 35$.

[3.5 Marks]

c) Briefly explain the difference between active and passive circuit elements.

[1.5 Marks]

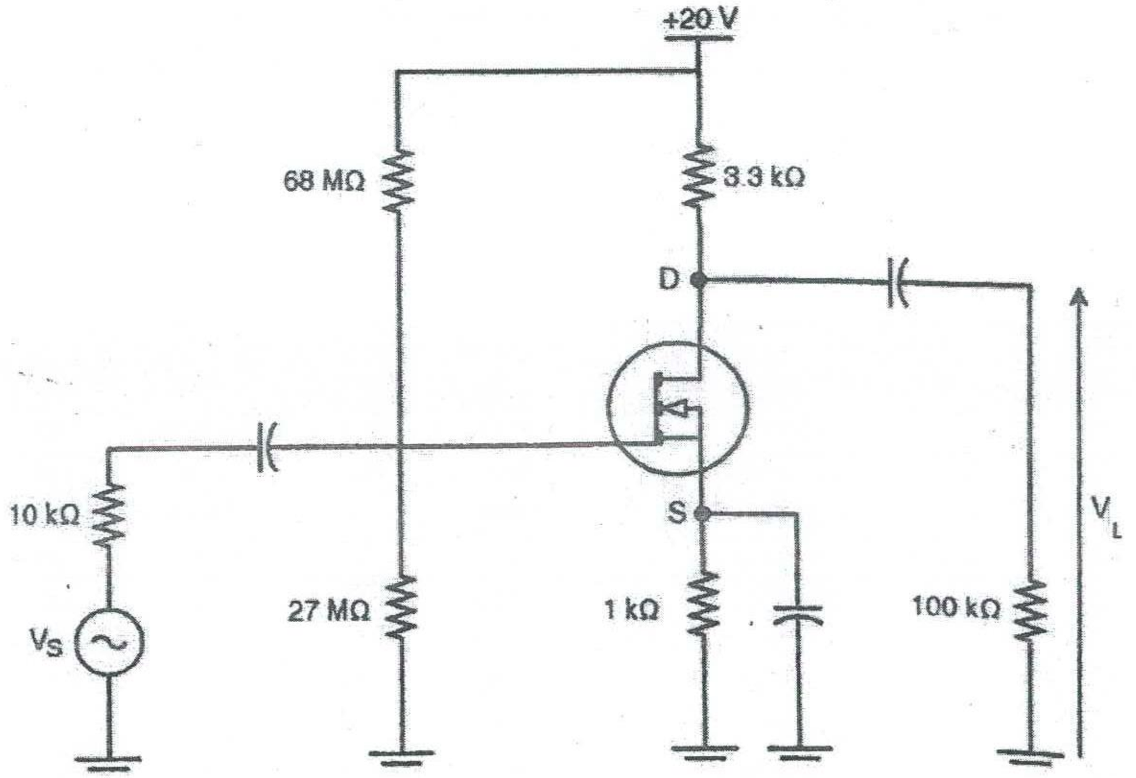

Figure Q1. 1

Table Q2.1

Type	a_i	b_i	Capacitance
Filter 1	$a_1 = 1.0000$	$b_1 = 0.0000$	15 nF
Filter 2	$a_2 = 1.6180$	$b_2 = 1.0000$	680 pF
Filter 3	$a_3 = 0.6180$	$b_3 = 1.0000$	120 pF

Table Q2.2

1% Resistor Table (E96)											
100	102	105	107	110	113	115	118	121	124	127	130
133	137	140	143	147	150	154	158	162	165	169	174
178	182	187	191	196	200	205	210	215	221	226	232
237	243	249	255	261	267	274	280	287	294	301	309
316	324	332	340	348	357	365	374	383	392	402	412
422	432	442	453	464	475	487	499	511	523	536	549
562	576	590	604	619	634	649	665	681	698	715	732
750	768	787	806	825	845	866	887	909	931	953	976

Table Q2.3

Picofarad (pF)	Nanofarad (nF)	Microfarad (uF)	Code	Picofarad (pF)	Nanofarad (nF)	Microfarad (uF)	Code
10	0.01	0.00001	100	4700	4.7	0.0047	472
15	0.015	0.000015	150	5000	5.0	0.005	502
22	0.022	0.000022	220	5600	5.6	0.0056	562
33	0.033	0.000033	330	6800	6.8	0.0068	682
47	0.047	0.000047	470	10000	10	0.01	103
100	0.1	0.0001	101	15000	15	0.015	153
120	0.12	0.00012	121	22000	22	0.022	223
130	0.13	0.00013	131	33000	33	0.033	333
150	0.15	0.00015	151	47000	47	0.047	473
180	0.18	0.00018	181	68000	68	0.068	683
220	0.22	0.00022	221	100000	100	0.1	104
330	0.33	0.00033	331	150000	150	0.15	154
470	0.47	0.00047	471	200000	200	0.2	254
560	0.56	0.00056	561	220000	220	0.22	224
680	0.68	0.00068	681	330000	330	0.33	334
750	0.75	0.00075	751	470000	470	0.47	474
820	0.82	0.00082	821	680000	680	0.68	684
1000	1.0	0.001	102	1000000	1000	1.0	105
1500	1.5	0.0015	152	1500000	1500	1.5	155
2000	2.0	0.002	202	2000000	2000	2.0	205
2200	2.2	0.0022	222	2200000	2200	2.2	225
3300	3.3	0.0033	332	3300000	3300	3.3	335

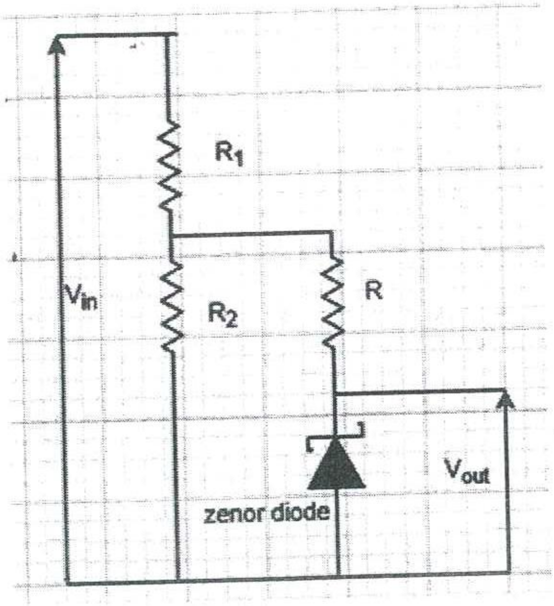

Figure Q4.1

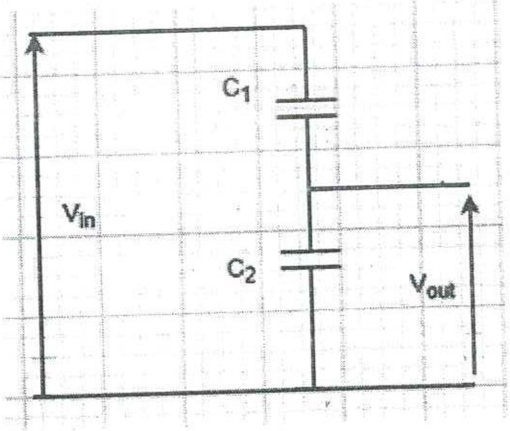

Figure Q4.2