NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING DEGREE
ADVANCED INTEGRATED CIRCUITS AND MICROELECTRONICS – TEE 5111
SUPPLEMENTARY EXAMINATION – AUGUST 2011
DURATION 3 HOURS

INSTRUCTIONS TO CANDIDATES
1. ANSWER **ANY FOUR** QUESTIONS
2. EACH QUESTION CARRIES EQUAL MARKS
3. SHOW YOUR STEPS CLEARLY IN CALCULATIONS
4. START THE ANSWER FOR EACH QUESTION ON A FRESH PAGE

Q. 1.

a) Describe the characteristics of an operational amplifier classified as 'Low Noise'.

[4 points]

b) Explain the procedure in integrated circuits fabrication called 'Oxidation'.

[8 points]

c) Show the circuit diagram of a Widlar Current Source. Give the relationship between the input and the output current.

[6 points]

d) Give the block diagram of a Basic Isolation Amplifier. Explain its operation.

[7 points]

Q. 2.

a) Describe the characteristics of an operational amplifier classified as 'Low Drift'.

[4 points]

b) Explain the procedure in integrated circuits fabrication called 'Zone Refining'.

[6 points]

c) Show the circuit diagram of a Simple Current Source. Give the relationship between the input and the output current.

[6 points]

d) A SiO_2 layer of 0.4 μm is to be grown on (100) silicon by dry oxidation at temperature of 1000 °C. Find the time required using the information below.

$$x_o = \frac{A}{2}\left[\sqrt{\left(1+\frac{t+\tau_o}{A^2/4B}\right)}-1\right], \text{ where } \tau_o = \frac{x_i^2 + Ax_i}{B};$$

$$t = \frac{A^2}{4B}\left[\left(\frac{2x_o}{A}+1\right)^2 - 1\right] - \tau_o, \; A = K_1 e^{+E_1/kT} \text{ and } B = K_2 e^{-E_2/kt}$$

Parameter	(111) Silicon		(100) Silicon	
	Wet	Dry	Wet	Dry
K_1 (μm)	$2.39.10^{-6}$	$1.24.10^{-4}$	$4.02.10^{-6}$	$2.08.10^{-4}$
K_2(μm^2/hour)	214	772	214	772
E_1 (eV)	1.29	0.77	1.29	0.77
E_2 (eV)	0.77	1.23	0.71	1.23
x_i (μm)	0	0.02	0	0.02

$k = 8.63.10^{-5}$ eV/ °K

[9 points]

Q. 3.

a) Describe the characteristics of an operational amplifier classified as 'Wide-band'.

[4 points]

b) Explain the procedure in integrated circuits fabrication called 'Photolithography'.

[8 points]

c) Show the circuit diagram of a level – shifter circuit using a Voltage Multiplier. Give the relationship between the input and the output voltage.

[6 points]

d) Give the circuit diagram of an Instrumentation Amplifier and derive expression for its voltage gain.

[7 points]

Q. 4.

a) Describe the characteristics of an operational amplifier classified as 'High Current'.

[4 points]

b) Explain the procedure in integrated circuits fabrication called 'Diffusion'.

[7 points]

c) Show the circuit diagram of an R/2R ladder Digital – to – Analogue Converter. Use equivalent circuits to prove the circuit operation for the following conditions:

D_0	D_1	D_2	D_3
1	1	0	1
0	0	1	1
0	0	1	0
1	1	0	1

Assume that the logic 1 (high level) is 5 V.

[14 points]

Q. 5.

a) Describe the characteristics of an operational amplifier classified as 'High Voltage'.

[4 points]

b) Explain the procedure in integrated circuits fabrication called 'Crystal Growth'.

[5 points]

c) Show the circuit diagram of a Multiple Current Source. Explain the practical application of a such source.

[6 points]

d) Give circuit diagram, illustrate and explain the principle of operation of:

(i) A Voltage to Frequency Converter;
(ii) A Frequency to Voltage Converter.

[10 points]

Q. 6.

a) Describe the characteristics of an operational amplifier classified as ' Low Bias Current'.

[4 points]

b) Explain the procedure in integrated circuits fabrication called 'Metalization'.

[6 points]

c) Show the circuit diagram of a level – shifter circuit using a Darlington Pair. Give the relationship between the input and the output voltage.

[7 points]

d) Show the circuit of a Differential Amplifier as a monolithic integrated circuit. Derive an expression for:
   - The differential close-loop voltage gain
   - The common-mode voltage gain.

[8 points]