2521/105 2602/106
2601/106 2603/106
ELECTRICAL MEASUREMENT
AND ANALOGUE ELECTRONICS
June/July 2016
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING
(INSTRUMENTATION OPTION)
(TELECOMMUNICATION OPTION)
(POWER OPTION)

MODULE I

ELECTRICAL MEASUREMENT AND ANALOGUE ELECTRONICS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Drawing instruments;
Non-programmable electronic calculator;
Mathematical tables.

*This paper consists **EIGHT** questions into **TWO** sections; **A** and **B**.*
*Answer any **THREE** questions from section **A** and any **TWO** questions from section **B** in the answer booklet provided.*
All questions carry equal marks.
Maximum marks for each part of a question are as shown.
Candidates should answer the questions in English.

This paper consists of 5 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A: ELECTRICAL MEASUREMENTS

*Answer any **THREE** questions in this section.*

1. (a) Define the following system of units as applied in measurements:

(i) absolute unit;
(ii) derived unit. (2 marks)

(b) Derive the dimensions of the following quantities using the electrostatic system of units:

(i) charge (Q);
(ii) current (I). (8 marks)

(c) State **four** advantages of the MKS system of units in electrical measurements. (4 marks)

(d) Using the LMTI system of units, derive the dimensional equations for:

(i) EMF;
(ii) magnetic flux density. (6 marks)

2. (a) Explain the following types of measurement errors:

(i) environmental errors;
(ii) instrumental errors;
(iii) gross errors;
(iv) residue errors. (8 marks)

(b) State **three** detectors and their operational frequencies as commonly used for a.c. bridges. (6 marks)

(c) Explain how the following factors affect precision measurement of medium resistance with wheatstone bridge:

(i) temperature effects;
(ii) contact resistance;
(iii) thermo-electric effects. (6 marks)

(a) State **three** causes of faults on a printed circuit board. (3 marks)

(b) List **five** tools used in the repair and maintenance of electronic equipment. (5 marks)

(c) Explain **three** points a service engineer should consider when fault finding on electronic equipment. (6 marks)

d) Outline **three** operational objectives and **three** cost objectives of good maintenance. (6 marks)

(a) Describe the term 'reliability' as applied in electrical measurements. (4 marks)

(b) Explain the importance of the following in relation to reliability:

(i) mean time between failures;
(ii) mean time to failure;
(iii) availability. (6 marks)

(c) Table 1 shows the performance of ten pressure monitors, observed while operating for a period of 1200 hours. Every failed unit is replaced immediately. Determine the:

(i) MTBF;
(ii) failure rate (10 marks)

Table 1

Unit Number	Time of Failure (hours)	Failure
1	650	1
2	420	1
3	130 and 725	2
4	585	1
5	630 and 950	2
6	390	1
7	No failure	0
8	880	1
9	No failure	0
10	220 and 675	2

a) State **three** reasons for the inaccuracies encountered in magnetic measurements, (3 marks)

) Outline **six** methods of fault location in electronic systems. (6 marks)

) Explain the following wattmeter errors:

(i) eddy current errors;
(ii) stray magnetic field errors. (6 marks)

Draw a labelled construction diagram of Hibberts magnetic standard used in magnetic measurements. (5 marks)

SECTION B: ANALOGUE ELECTRONICS

*Answer any **TWO** questions from this section.*

6. (a) Explain how the following extrinsic semi-conductors are formed.

(i) N- type;
(ii) P-type. (4 marks)

(b) (i) State **three** applications of semi-conductor diodes
(ii) With aid of voltage-current characteristics, describe the avalanche breakdown in a P-N junction diode. (10 marks)

(c) A silicon diode has a forward voltage drop of 1.5V and a forward d.c. current of 150 mA. It has a reverse current of 1.2 μA and a reverse voltage of 12 V. Determine for the diode the:
(i) forward resistance;
(ii) reverse resistance. (6 marks)

7. (a) Draw equivalent two source biaising circuits using the transistor symbol for the following:

(i) PNP transistor;
(II) NPN transistor. (4 marks)

(b) Figure 1 shows an amplifier circuit.
(i) Determine the d.c. operating point.
(ii) Sketch the d.c. loadline.
NB: neglect V_{BE} (12 marks)

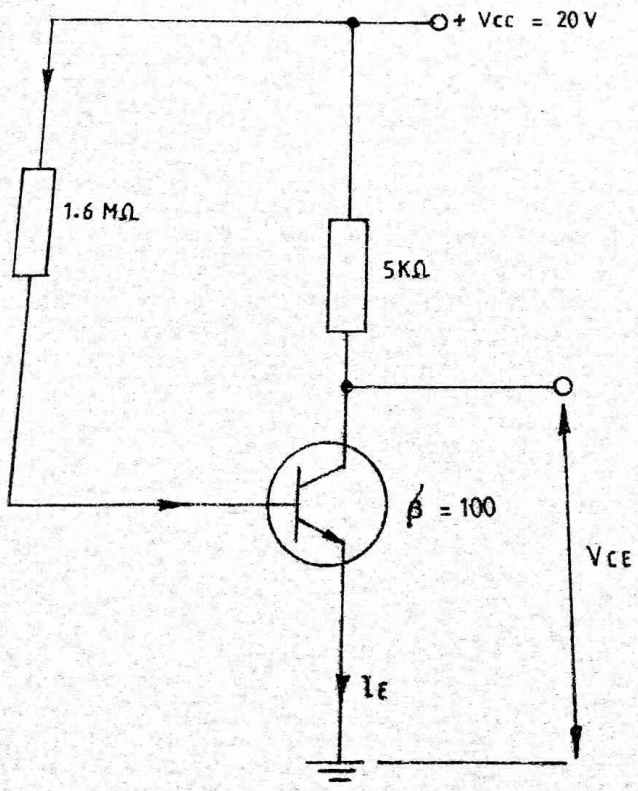

Fig. 1

(c) State **two** advantages and **two** disadvantages of field effect transistors over bipolar junction transistors. (4 marks)

(a) State **three** advantages of bridge rectifier over bi-phase rectifier. (3 marks)

(b) (i) With aid of circuit diagram and voltage waveforms, describe the operation of a single phase half wave rectifier feeding a purely resistive load.

(ii) Derive the expression for the output d.c. current for the rectifier in b(i). (11 marks)

(c) Figure 2 shows a zener diode stabilizer. Determine the output voltage with no load current. (6 marks)

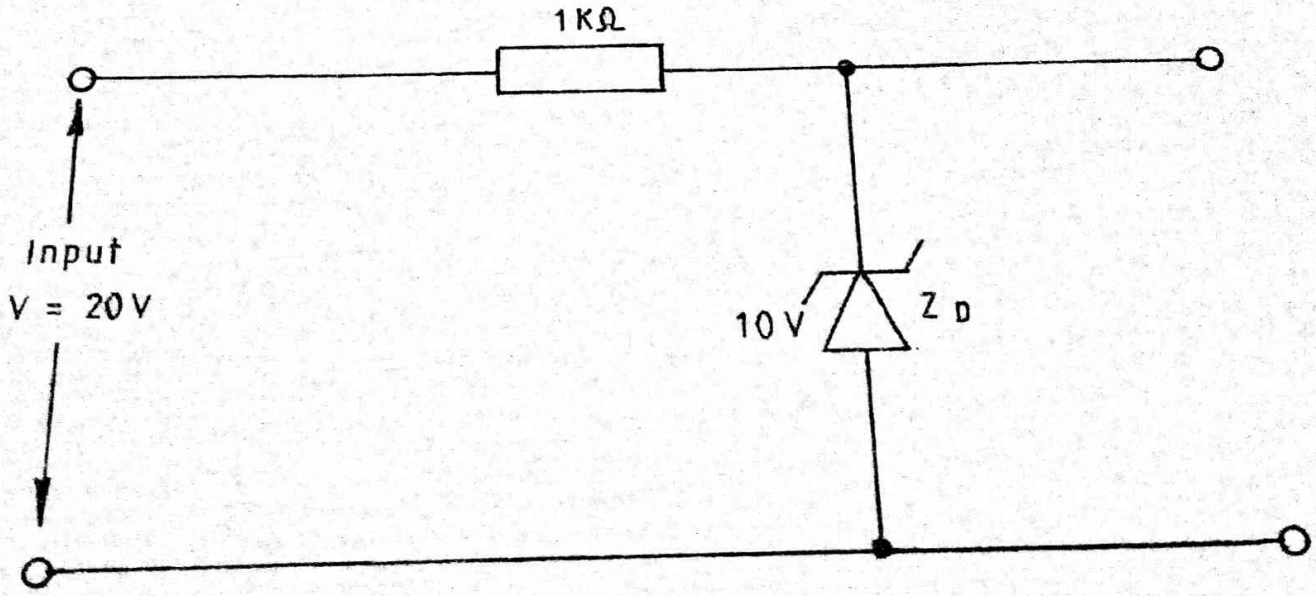

Fig. 2

2521/105, 2602/106
2601/106, 2603/106
ELECTRICAL MEASUREMENTS AND
ANALOGUE ELECTRONICS
Oct./Nov. 2016
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING
(POWER OPTION)
(TELECOMMUNICATION OPTION)
(INSTRUMENTATION OPTION)
MODULE I

ELECTRICAL MEASUREMENTS AND ANALOGUE ELECTRONICS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination.
Mathematical table/Non-programmable scientific calculator;
Drawing instruments
Graph paper.
*The paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer any **THREE** questions from section **A** and any **TWO** questions from section **B** in the answer booklet provided.*
All questions carry equal marks.
Maximum marks for each part of the question are as indicated.
Candidates should answer all questions in English.

This paper consists of 7 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A: ELECTRICAL MEASUREMENTS

*Answer any **THREE** questions from this section.*

1. (a) (i) State any **two** factors that affect equipment reliability.

(ii) Sketch the curve of failure rate against time for an equipment and explain its shape.

(8 marks)

(b) Table 1 shows the mean time between failure (MTBF) for various units of an electronic equipment connected in series. For an operating period of 1,000 hours, determine the reliability of:

(i) each unit;
(ii) the equipment.

(8 marks)

Table 1

Unit	MTBF (hrs)
Power supply	30,000
Pre-amplifier	100,000
Oscillator	60,000
Modulator	75,000
Power amplifier	40,000

(c) A generator system designed for continuous operation fails three times in one year. If the total time to repair is 14 days, determine the:

(i) mean time to repair (MTTR), in days;
(ii) mean time between failure (MTBF), in days.

(4 marks)

(a) (i) State any **two** advantages of MKS over CGS system of units.

(ii) Show that one unit of charge (Q) in cgs electromagnetic units is equal to one unit of charge in MKS units.

(8 marks)

(b) Derive the dimensional expression for each of the following electrical quantities in the specified cgs units:

(i) charge (Q) in e.s.u;
(ii) magnetising force (H) in e.m.u.

(12 marks)

(b) Describe the procedure of measuring the depth of modulation of an amplitude modulated (AM) wave using an oscilloscope with the internal timebase switched off and sketch the displayed waveform. (6 marks)

(c) A spring controlled electrostatic voltmeter has a total capacitance of 35.4θ pF, where θ is the angle of deflection of the movable plates. Determine the spring constant (in Nm/rad) of the voltmeter if 10 kV corresponds to a full-scale deflection of 100 degrees. (4 marks)

(i) State any **three** detectors used in a.c. bridges.

(ii) Figure 1 shows a circuit diagram of an a.c. bridge.

(I) Derive the bridge equation at balance.

(II) Determine the value of R_1 and L_1. (10 marks)

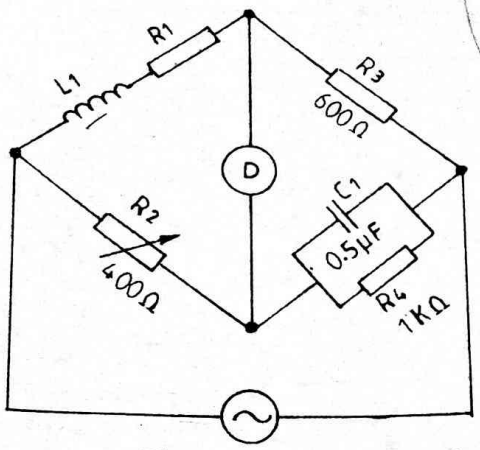

Fig. 1

(a) State any **two**:

(I) factors that may cause premature failure of capacitors;

(II) precautions to be observed when handling and testing electronic components. (4 marks)

(b) Figure 2 shows a circuit diagram of an amplifier.

(i) Estimate the voltage at the test points TP_1, TP_2 and TP_3 for each of the following faults:

(I) resistor R_1 open circuit;
(II) transistor base-emitter junction short circuit.

(ii) Explain the effect of an open circuit in capacitor C_3.

(10 mar

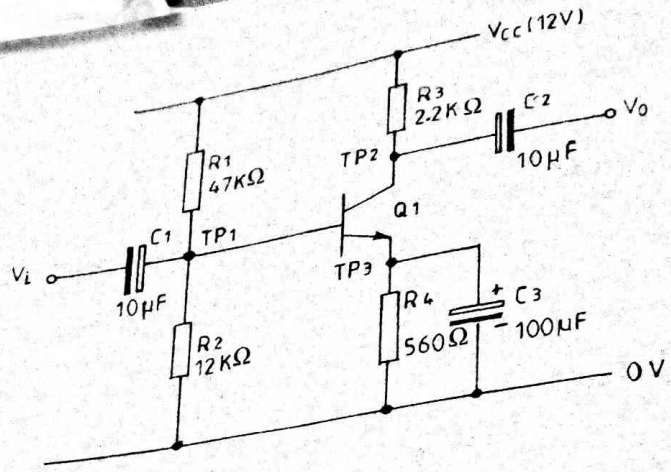

Fig. 2

(c) Figure 3 shows a block diagram of an over-temperature alarm system. It is suspected that a fault has occurred in the power supply section such that there is no indication on the alarm outputs. Develop a fault location chart for the system. (6 marks)

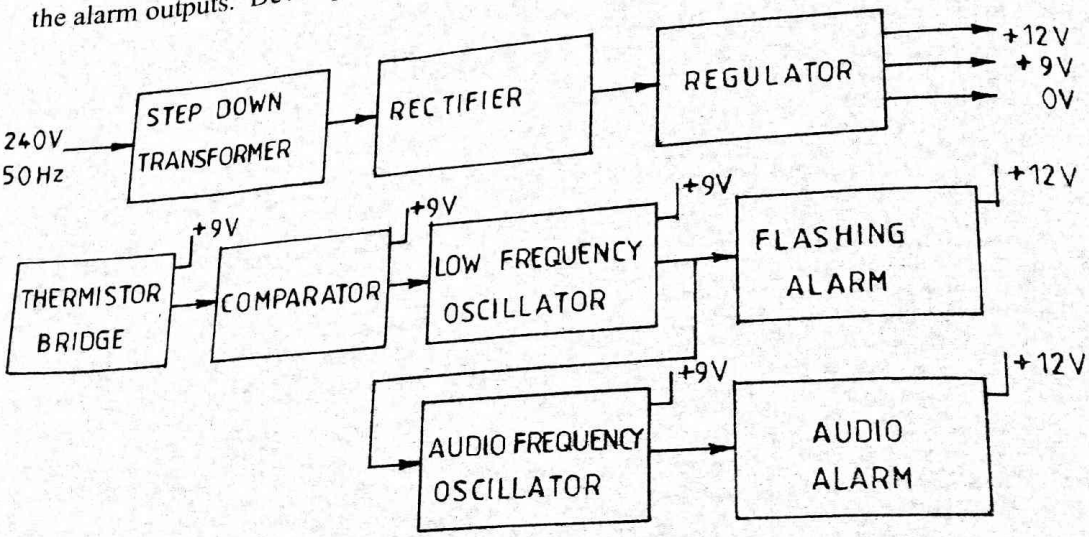

Fig. 3

(a) (i) State any **two** ways of minimising the effect of environmental errors in measurements.

(ii) With the aid of a labelled diagram, describe the operation of a thermocouple ammeter.

(iii) A thermocouple ammeter is assumed to have a perfect square law response. If gives a full-scale deflection for a current of 10A, determine the current to give half-scale deflection.

(10 marl

In a magnetic test, a flux meter is connected to a search coil having 500 turns and a mean area of 500 mm^2. The search coil is placed at the centre of a solenoid 1 m long, wound with 800 turns. When a current of 5A is reversed, there is a deflection of 25 scale divisions. Taking $\mu_0 = 4\pi \times 10^{-7}$ H/m, determine the:

(i) flux density in the solenoid;

(ii) flux linkages per scale division for the meter.

(10 marks)

SECTION B: ANALOGUE ELECTRONICS I

Answer any ***TWO*** *questions from this section.*

(a) (i) Define each of the following with respect to atomic theory:

(I) atomic number;

(II) ionization potential.

(ii) Draw labelled energy-band structure for each of the following:

(I) insulator;

(II) semiconductor.

(6 marks)

(b) (i) Explain thermionic emission as applied to metals.

(ii) An electrostatic CRT has a final anode voltage of 2kV and parallel deflection plates 2 cm long and 5 mm apart. The screen is 30 cm from the centre of deflection plates. If a deflection voltage of 100V is applied across the plates, determine the:

(I) maximum deflection, in cm;

(II) sensitivity of CRT, in mm/V;

(III) deflection factor, in V/mm.

(10 marks)

c) Sketch on the same axis the characteristic curve of a silicon diode at temperatures of 100 °C and 200 °C.

(4 marks)

) (i) State any **two** advantages of FETs over BJTs.

(ii) With the aid of a labelled diagram, describe the operation of a bipolar NPN transistor.

(9 marks)

(b) Figure 4 shows a circuit diagram of a JFET amplifier while table 2 shows the variation of drain current (I_D) with gate-source voltage (V_{GS}) for the JFET.

(i) Plot the transfer curve.
(ii) Construct the dc loadline. (11 marks)

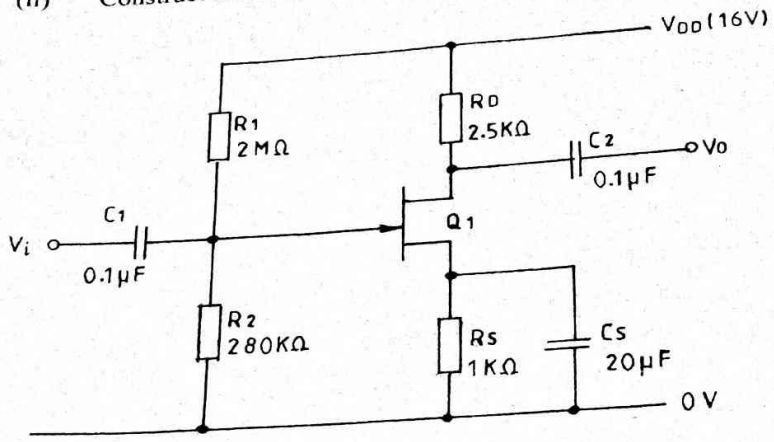

Fig. 4

Table 2

V_{GS} (V)	I_D (mA)
0	8
-1	4.5
-2	2
-3	0.5
-4	0

8. (a) (i) Define each of the following with respect to dc power supplies:

(I) peak inverse voltage;
(II) ripple factor.

(ii) A half-wave diode rectifier feeds a pure resistive load. Derive the expression for the dc output voltage.

(7 marks)

(b) With the aid of a circuit diagram, describe the operation of a full-wave voltage doubler. (6 marks)

(c) Figure 5 shows a circuit diagram of a shunt regulator using a Zener diode. Determine the:

(i) minimum value of R_L that the Zener will tolerate in maintaining V_L constant;

(ii) minimum value of load current;

(iii) maximum value of load current.

(7 marks)

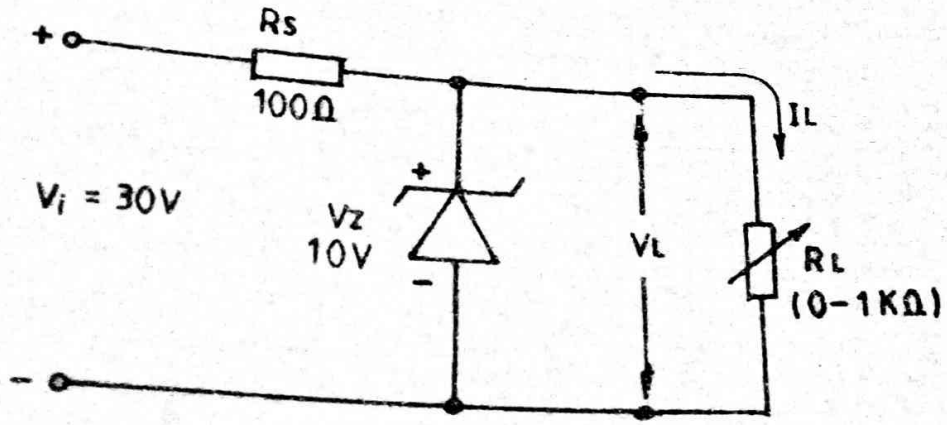

Fig. 5

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ELECTRICAL MEASUREMENT
AND ANALOGUE ELECTRONICS
Oct./Nov. 2014
Time: 3 hours

Index No:_____

Candidate's Signature:_____

Date:_____

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING
(POWER OPTION)
(TELECOMMUNICATION OPTION)
(INSTRUMENTATION OPTION)
MODULE I

ELECTRICAL MEASUREMENT AND ANALOGUE ELECTRONICS

3 hours

INSTRUCTIONS TO CANDIDATES

Write your name and index number in the spaces provided above.
Sign and write the date of examination in the spaces provided above.
You should have a mathematical table and an electronic calculator for this examination.
*This paper consists of **TWO** sections; **A** and **B**.*
*Answer any **THREE** questions from section **A**, and any **TWO** questions from section **B** in the spaces provided in this question paper.*
Maximum marks for each part of a question are indicated.
*Do **NOT** remove any pages from this booklet.*
Candidates should answer the questions in English.

For Examiner's Use Only

Section	Questions	Maximum Score	Candidate's Score
A		20	
		20	
		20	
B		20	
		20	
	Total Score		

This paper consists of 20 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A

*Answer any **THREE** questions from this section.*

1. (a) (i) State **three** advantages of MKS system over the CGS system of units. (3 marks)

(b) Derive the dimensions of the following using electrostatic system of units:

(i) charge;
(ii) potential difference. (11 marks)

(c) Describe the following types of standards as used in electrical measurement systems:

(i) secondary standards;

(ii) primary standards. (6 marks)

2. (a) With aid of a labelled diagram describe the operation of a flux meter. (6 marks)

(b) (i) State any **three** errors in electrodynamometer wattmeters;

(ii) The power in a three phase three wire balanced load system is measured by two wattmeter method. The reading of wattmeter A is 7 kW and that of B is –1.2 kW.

Determine the:

I. power factor;
II. total power of the system.

(8 marks)

(c) A series circuit consisting of a coil, a resistance and a variable capacitor is tunned to resonance using a Q-meter. When the Q-meter indicates 90, the frequency is 600 kHz, the resistance 0.6 Ω and the variable capacitor is 350 pF.

(i) sketch the circuit and phasor diagram;

(ii) determine the effective inductance of the coil.

(6 marks)

(a) Explain the following with respect to electronic component failure:

(i) partial failure;

(ii) catastrophic failure. (4 marks)

(b) Indicate any **two** probable failures for the various components in table 1. (8 marks)

Table 1

Component	**Common type of fault/failure**
Resistors	
Capacitors	
Semiconductor devices	
Thermionic valves	

(c) State any **three** financial benefits of good maintenance. (3 marks)

(d) (i) Explain the term "routine maintenance";

(ii) State **three** advantages of d (i) above. (5 marks)

(a) (i) Explain the term 'reliability'.

(ii) State any **four** causes of failure in electrical equipment. (7 marks)

(b) Draw a labelled bathtub curve and describe its shape. (9 marks)

(c) Ten items were tested for 50 hours each and five of the test units failed at times of 11, 15, 25, 30 and 42 hours respectively. Determine the failure rate. (4 marks)

(a) List any **three** tools used in repairing a faulty electronic amplifier. (3 marks)

(b) (i) State any **three** faults that may occur on printed circuit boards.

(ii) Describe the following PCB soldering processes:

I. wave;
II. reflow.

(9 marks)

(c) Figure 1 shows the circuit for measurement of resistance R. Derive the expression for the true value of R. (4 marks)

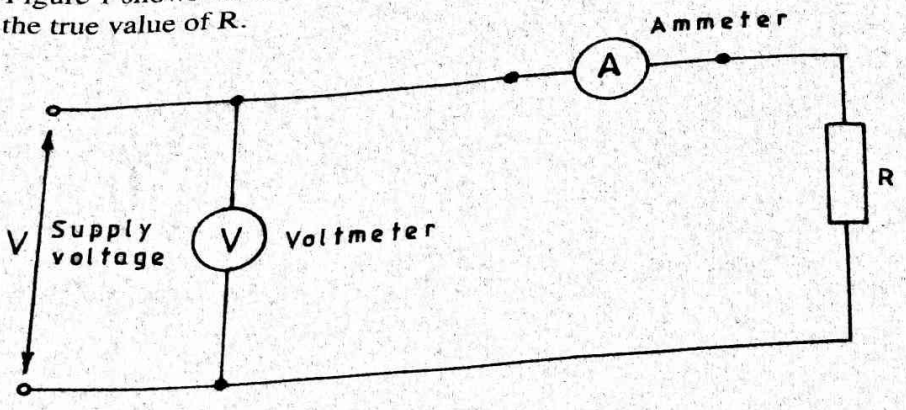

Fig. 1

(d) Draw a labelled block diagram of a digital frequency meter. (4 marks)

SECTION B

*Answer any **TWO** questions from this section.*

6. (a) (i) State any **two** applications of the cathode ray oscilloscope.

(ii) With aid of a labelled block diagram describe the operation of the cathode ray tube.

(10 marks)

(b) State the **two** common types of semiconductor materials. (2 marks)

(c) (i) With aid of a diagram explain the covalent bonding of an intrinsic semiconductor.

(ii) Explain the effect of temperature change in intrinsic semiconductor materials.

(6 marks)

(d) Explain how extrinsic semiconductors are formed. (2 marks)

(i) With aid of a circuit diagram and voltage-current (V/I) characteristics describe the operation of a P-N junction diode when forward biased.

(ii) State any **two** applications of semiconductor diodes. (10 marks)

(b) (i) State **two** effects of an incorrectly biased transistor.

(ii) Figure 2 shows a potential divider bias circuit. Assuming $I_C \simeq I_E$, determine:

I. Ic (sat);
II. Ic;
III. V_{CE}.

(10 marks)

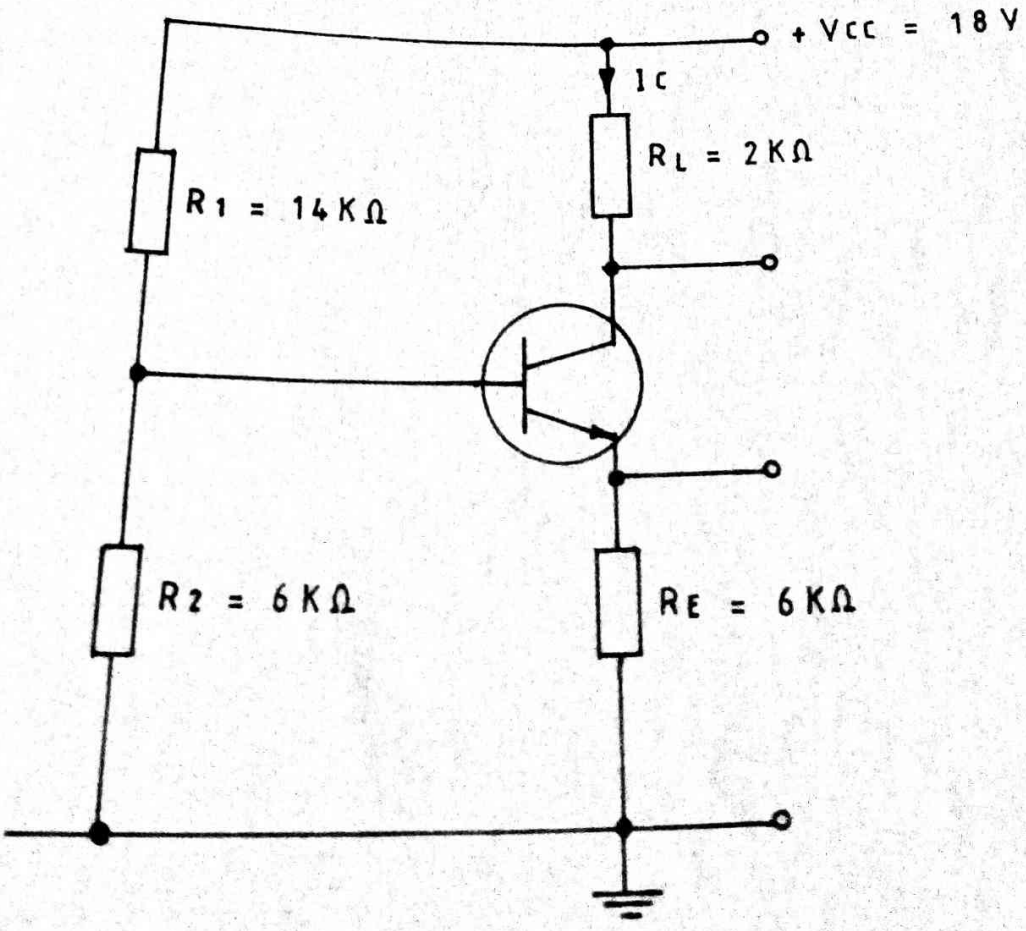

Fig. 2

8. (a) With aid of a diagram show the construction of a depletion enhancement metal oxide semiconductor field effect transistor (DE-MOSFET). (3 marks)

(b) With aid of circuit and waveform diagrams describe the operation of a single phase half wave rectifier feeding a resistive load. (8 marks)

(c) (i) State the main function of a filter circuit in power supplies.

(ii) Figure 3 shows a zener diode regulator circuit which has the following parameters: Vz = 6.8V at Iz 50 mA, $r_z = 2\Omega$ at Iz = 50 mA, Iz (min) = 5 mA and Iz (max) = 150 mA. Given that the load current varies from 20 mA to 120 mA, determine the load voltage. (9 marks)

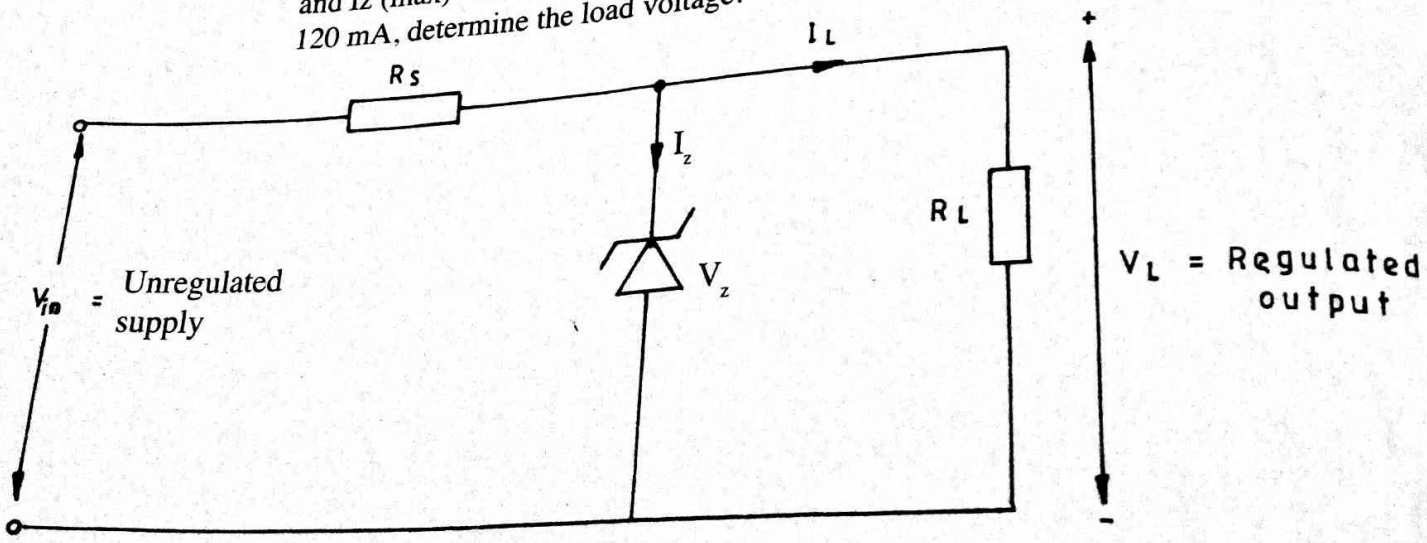

Fig. 3

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ELECTRICAL MEASUREMENT AND ANALOGUE ELECTRONICS
Oct/Nov 2012
Time: 3 hours

Index No: _____

Candidate's Signature: _____

Date: _____

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONICS ENGINEERING
(POWER OPTION)
(TELECOMMUNICATION OPTION)
(INSTRUMENTATION OPTION)
MODULE I

ELECTRICAL MEASUREMENT AND ANALOGUE ELECTRONICS

3 hours

INSTRUCTIONS TO CANDIDATES

Write your name and index number in the spaces provided at the top of this page.
Sign and write the date of examination in the spaces provided above.
You should have the following for this examination:
Mathematics table/ Electronic calculator.
*This paper consists of **TWO** sections; **A** and **B**.*
*Answer any **THREE** questions from section **A** and any **TWO** questions from section **B**.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.

For Examiner's Use Only

Sections	Question	Maximum Score	Candidate's Score
A	1	20	
	2	20	
	3	20	
	4	20	
	5	20	
B	6	20	
	7	20	
	8	20	
		Total Score	

This paper consists of 16 printed pages.

Candidates should check the question paper to ascertain that all th pages are printed as indicated and that no questions are missing

SECTION A

*Answer any **THREE** questions from this section in the spaces provided.*

1. (a) State any **three** advantages of Standard International (SI) units of measurement. (3 marks)

(b) Using MKSA system of unit derive the dimensional equations of: (7 marks)

(i) e.m.f;
(ii) magnetic flux density;
(iii) capacitance.

(c) The energy stored in a parallel plate capacitor per unit volume (energy density) is given by: $W = K\varepsilon^a V^b d^c$

where ε = permittivity of the medium
d = distance between plates
V = voltage between plates
K = a constant

Find the values of a, b, and c using LMT I system of units. (10 marks)

2. (a) *List **three** detectors used in a.c bridges and state their operational frequency range.* (6 marks)

(b) Figure 1 shows an a.c bridge network at balance. Derive the expression for L_1 and R_1.

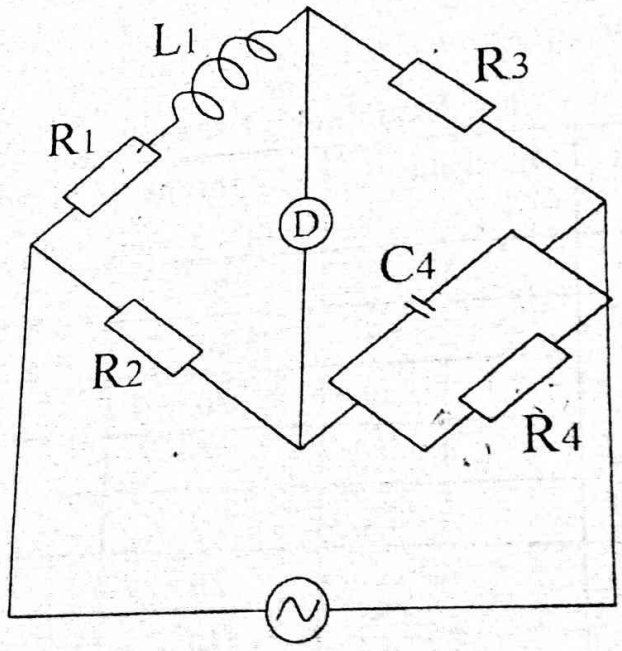

Figure 1 (7 mark

(c) With aid of diagram, describe the substitution method of measurement of medium resistance. (7 mar

(b) State **two** advantages of LLoyd Fisher square method over Epstein square in the measurement of magnetic flux. (2 marks)

(c) An iron ring has a mean diameter of 0.1 m and a cross section of 33.5 mm^2. Its wound with a magnetising winding of 300 turns and a secondary winding of 200 turns. On reversing a current of 10 A in the magnetising winding a ballistic galvanometer gives a throw of 276 scale divisions, while a Hibbert magnetic standard with 11 turns and a flux of 0.22×10^{-3} wb gives a reading of 100 scale divisions other conditions remaining the same. Determine the relative permeability of the specimen. (6 marks)

With aid of a diagram explain the operation of:

(i) electrostatic voltmeter used in measurement of a.c quantities;

(ii) resonance method of frequency measurement. (12 marks)

(a) Differentiate between availability and unavailability of an equipment. (4 marks)

(b) State any **three** causes of failure in equipment. (3 marks)

(c) A television set which is under test, fails 3 times after each uptimes of 120 hours, 98 hours and 155 hours respectively. Determine the:

(i) mean time between failure (MTBF);

(ii) failure rate (FR). (6 marks)

(d) With aid of a block diagram, explain the half split method used in fault diagnosis of electronic circuits. (7 marks)

(a) State any **two** contents of the following documents used in corrective maintenance:

(i) work card;

(ii) history card. (4 marks)

(b) Explain the **three** functions carried out in preventive maintenance of an equipment. (6 marks)

(c) Explain the process of soldering. (7 marks)

(d) State **three** characteristics of a logic probe used in troubleshooting electronic circuits. (3 marks)

SECTION B

*Answer any **TWO** questions from this section in the spaces provided.*

6. (a) State the **three** circuit configuration of field effect transistors. (3 marks)

(b) With aid of a transfer characteristic curve describe the operation of a DEMOSFET. (7 marks)

(c) Figure 2 shows an amplifier circuit. Calculate the biasing values and draw on the same axis the d.c and a.c loadlines.

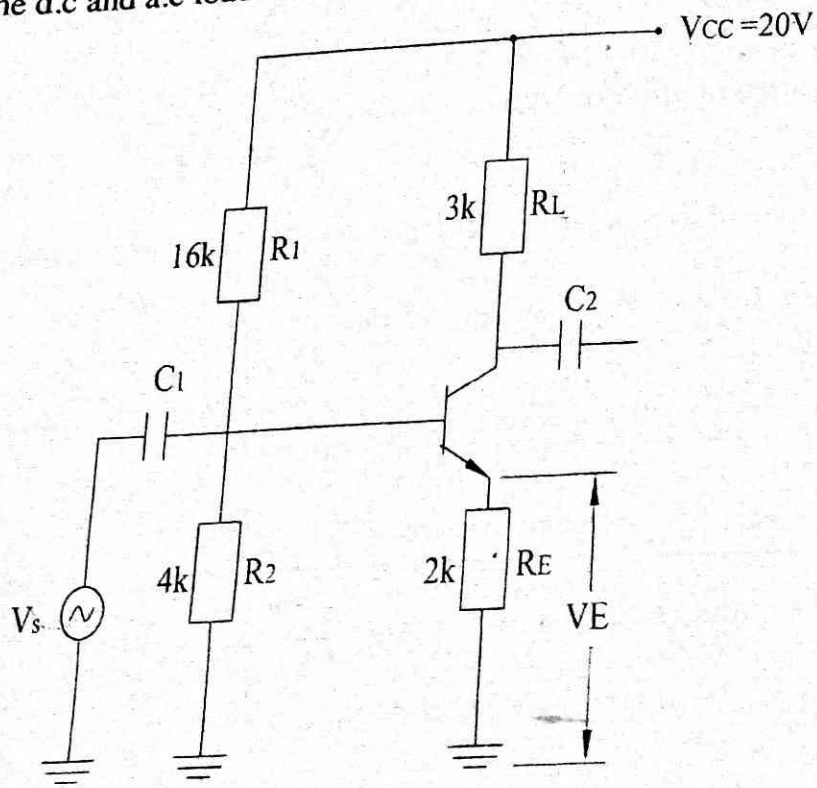

Figure 2

(10 marks)

(a) With aid of a circuit and waveform diagrams explain the operation of full wave voltage doubler circuit. (8 marks)

(b) With aid of characteristic curves, describe the biasing of a PN junction diode. (6 marks)

Figure 3 shows a FET amplifier circuit. Given the value of drain current is 4 mA, calculate the values of VDs and VGs.

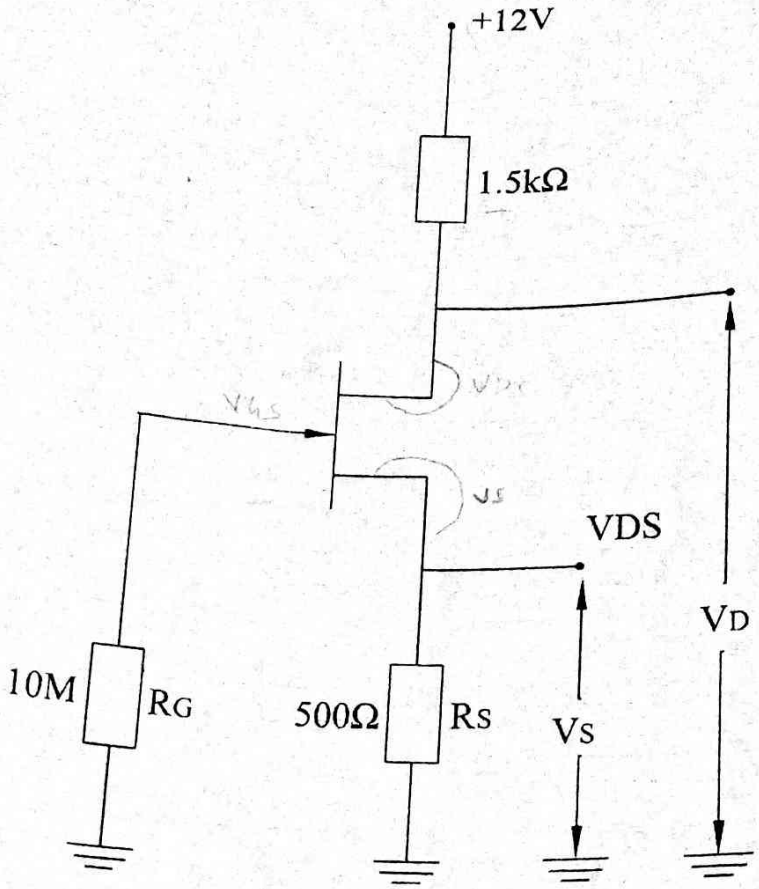

Figure 3

(6 marks)

(a) (i) Define the term rectification as used in power supplies.

(ii) Explain the formation of a P type extrinsic semiconductor material.

(8 marks)

b). Describe the electrostatic field deflection of electrons in a cathode ray tube.

(7 marks)

Describe the Bohr's model atomic structure. (5 marks)

(b) An amplifier has a gain A = 100, input resistance $Ri = 2K\,\Omega$ and output resistance $Ro = 40\,K\,\Omega$. Determine the following when it is connected as a voltage-series negative feedback amplifier with a feedback factor $\beta = 1/10$:

(i) gain;
(ii) input resistance;
(iii) output resistance;
(iv) reduction in distortion;
(v) percentage change in gain with feedback if the gain without feedback changes by 20%.

(10 marks)

3. (a) (i) Define the following with respect to operational amplifiers:

(I) input offset voltage;
(II) slew rate;
(III) common-mode voltage gain.

(ii) Figure 2 shows a circuit diagram of a first-order low-pass filter. Determine the:

(I) voltage gain;
(II) cutoff frequency.

(7 marks)

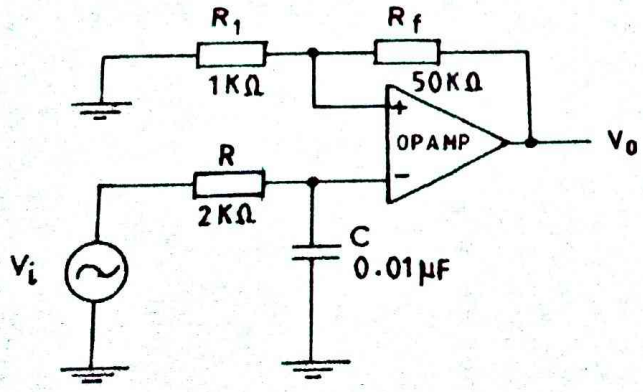

Fig. 2

(b) Table 1 shows the data of the gain/frequency characteristic of a two-stage tuned radio frequency amplifier.

(i) Plot, on the same axis, the gain/frequency curves for:

(I) single stage;
(II) two stages.

(ii) From the curves, determine the bandwidth of the single stage and the two stage

(7 mark

Table 2

	0	1	2	3	4	5	6	7
0	NUL	DLE	SP	0	@	P		P
1	SOH	DC1	!	1	A	Q	a	q
2	STX	DC2	"	2	B	R	b	r
3	ETX	DC3	#	3	C	S	c	s
4	EOT	DC4	$	4	D	T	d	t
5	ENQ	NAK	%	5	E	U	e	u
6	ACK	SYN	&	6	F	V	f	v
7	BEL	ETB	'	7	G	W	g	w
8	BS	CAN	(	8	H	X	h	x
9	HT	EM	)	9	I	Y	i	y
A	LF	SUB	*	:	J	Z	j	z
B	VT	ESC	+	;	K	[	k	{
C	FF	FS	,	<	L	\	l	|
D	CR	GS	-	=	M	]	m	}
E	SO	RS	.	>	N	^	n	~
F	SI	US	/	?	O	-	o	DEL

(ii) Add 647_{10} to 492_{10} in the 8421 BCD code.

(8 marks)

5. (a) (i) Define the following with respect to edge-triggered flip-flops:

(I) set-up time;
(II) hold-up time.

(ii) With the aid of a logic diagram, describe the operation of a master-slave JK flip-flop when the clock is at logic 1 and makes a transition to logic 0. Assume the circuit is initially reset and the inputs J = K = 1.

(9 marks)

(b) (i) State **two** applications of binary counters.

(ii) Figure 3 shows a logic diagram of a binary counter. Describe its operation for three clock pulses and draw the timing diagrams.

(8 marks)

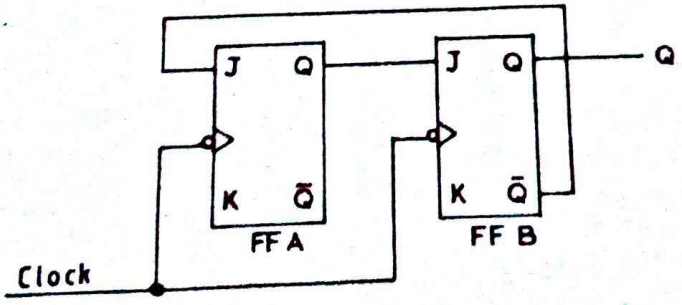

Fig. 3

(c) Draw the state diagram of a 4-bit Johnsons counter assuming that all the stages are in the '0' state.

(3 marks)

Turn over

SECTION A: ANALOGUE ELECTRONICS II

Answer any TWO questions from this section

1. (a) (i) State **two** advantages of a silicon controlled switch (SCS) over a silicon controlled rectifier (SCR).

(ii) Figure 1 shows a circuit diagram of an alarm system employing a silicon controlled switch. Describe its operation. (6 marks)

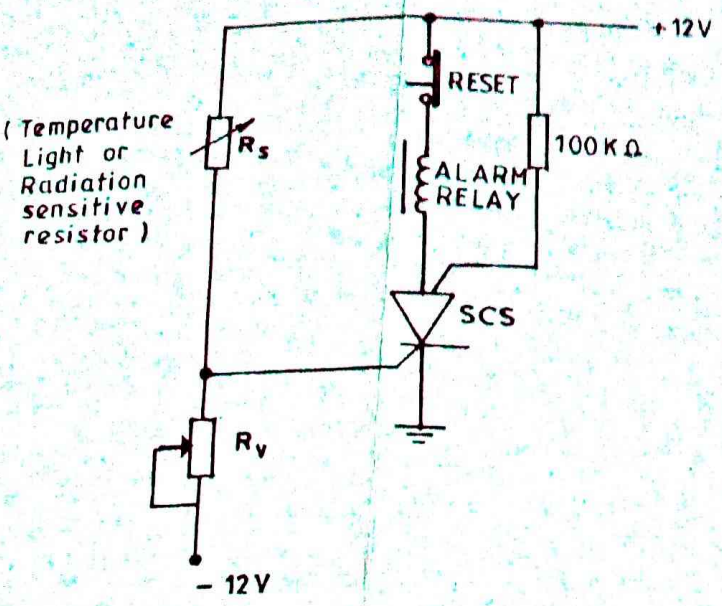

Fig. 1

(b) With the aid of a circuit diagram, describe the operation of a discrete-component bistable multivibrator. (8 marks)

(c) An LED has the following ratings: power output $P_0 = 0.42$ mW, forward current $I_F = 80$ mA and forward voltage $V_F = 1.22$V. It is connected in series with a current limiting resistor and supplied from a 5V source. The light from the LED is projected onto a flat surface 2.54 cm away and forms a divergence angle of 0.524 radians. Determine the:

(i) value of the current limiting resistor;
(ii) area illuminated by the LED;
(iii) incident irradiance at the flat surface. (6 marks)

(a) (i) State the **two** conditions necessary for oscillations to be sustained in a sinusoidal oscillator.

(ii) With the aid of a circuit diagram, describe the operation of a blocking oscillator. (10 marks)

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONICS ENGINEERING
(POWER OPTION)
(TELECOMMUNICATION OPTION)
(INSTRUMENTATION OPTION)
MODULE II

DIGITAL AND ANALOGUE ELECTRONICS II

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination.
Mathematical table/Non-programmable scientific calculator;
Graph paper.
*The paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer any **TWO** questions from section **A** and any **THREE** questions from section **B** in the answer booklet provided.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.
Candidates should answer questions in English.

This paper consists of 7 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

Turn ov

Table 1

Frequency	950	960	970	980	990	1000	1010	1020	1030	1040	1050
Gain of 1 stage	1.98	2.45	3.12	4.47	7.07	10	7.07	4.47	3.12	2.45	1.98
Gain of 2 stages	3.92	5.91	9.73	19.98	50	100	50	19.98	9.73	5.91	3.92

(c) Show that the maximum theoretical efficiency of a class-B power amplifier is 78.54%. (6 marks)

SECTION B: DIGITAL ELECTRONICS

*Answer any **THREE** questions from this section.*

4. (a) Perform the following number system conversion:

(i) 1011101001_2 to decimal;
(ii) $EB4A_{16}$ to decimal

(6 marks)

(b) Perform the following arithmetic operations in the given bases:

(i) $1011_2 \times 101_2$
(ii) $1A8_{16} + 67B_{16}$

(c) (i) Table 2 shows the ASC11 code for alphanumeric characters. Obtain the: (6 marks)

(I) code for the letter *e*;
(II) decimal number represented by the code 0111001.

(b) A iron ring has a mean diameter of 0.15 mm and cross-sectional of 35 mm². It is wound with a magnetising winding of 300 turns and a search coil of 250 turns. When a current of 8A is reversed in the magnetising winding, a ballistic galvanometer gives a throw of 270 scale divisions while a Hibbert magnetic standard with 15 turns and a flux of 0.3 mWb gives a reading of 100 scale divisions. Determine the:

(i) galvanometer constant, in Weber turn/scale division;
(ii) flux in the search coil;
(iii) flux density in the ring specimen.

(11 marks)

3. (a) (i) Distinguish between primary fundamental units and auxiliary fundamental units.

(ii) Derive, from first principles, the dimensional expression for each of the following mechanical quantities:

I. energy;
II. momentum.

(11 marks)

(b) The mean torque T of an electrical measuring instrument is given by the expression $T=M^aE^bZ^c$, where M = mutual inductance, E = applied voltage, Z = impedance of load circuit. The dimensions for each quantity is $T=[ML^2T^{-2}]$, $M=[\mu L]$, $E=[\mu^{\frac{1}{2}}M^{\frac{1}{2}}L^{\frac{1}{2}}T^{-2}]$ and $Z=[\mu LT^{-1}]$. Determine the values of a, b and c.

(9 marks)

4. (a) (i) State **three** common faults in each of the following components:

I. variable resistors;
II. Ceramic capacitors.

(ii) Describe how a desoldering pump is used.

(9 marks)

(b) State **one** effect of the following faults on the output voltage of a full-wave dc power supply:

(i) one diode in the rectifier open circuit;
(ii) reservoir capacitor filter open circuit;
(iii) mains transformer winding shorting to frame.

(3 marks)

8. (a) Draw a labelled block diagram of a regulated dc power supply. (4 marks)

(b) A full-wave bridge rectifier is supplied from a transformer whose secondary voltage is 60 Vrms.
Determine the:

(i) peak value of the secondary voltage;
(ii) dc voltage of the rectifier output;
(iii) ripple factor.

(6 marks)

(c) With the aid of a circuit diagram, describe the operation of a half-wave voltage doubler. (6 marks)

(d) A series inverter has an inductor of 12 mH and a capacitor of 47 μF connected in series with a load resistor of 8 Ω. Determine the:

(i) resonant frequency;
(ii) time period of oscillations.

(4 marks)

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(c) An electron beam in an electrostatic cathode ray tube travels at a velocity of 18×10^6 m/s and is deflected 10 cm from the initial direction of travel. The tube has deflection plates 2 cm long and 3.5 mm apart and a deflection factor of 2.7 V/mm. Taking mass of electron, $m = 9.1 \times 10^{-31}$ kg, electronic charge, $e = 1.6 \times 10^{-19}$C, determine the:

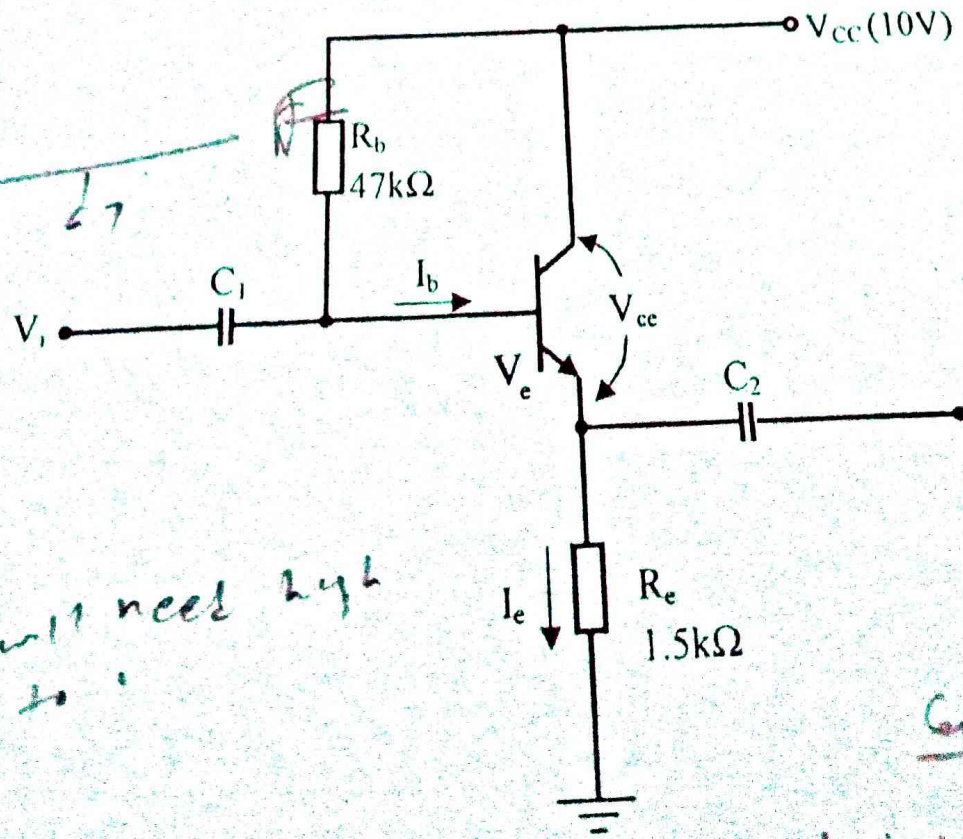
(i) value of the final anode voltage;
(ii) deflection sensitivity of the tube;
(iii) distance of the screen from the centre of deflecting plates;
(iv) Value of the voltage across the deflecting plates. (8 marks)

(d) List **four** parts of the electron gun assembly of a cathode-ray tube. (4 marks)

(a) (i) State **two** advantages of silicon over germanium diodes in rectifier circuits.
(ii) Sketch the characteristic curve of a reverse-biased p n junction diode and explain its shape. (7 marks)

(b) Figure 2 shows a circuit diagram of a transistor amplifier. Taking $V_{be} = 0.7$ V and $\beta = 45$, determine the

(i) base current, I_b;
(ii) emitter current, I_e;
(iii) collector-to-emitter voltage, V_{ce};
(iv) emitter terminal voltage, V_e. (8 marks)



(c) Table 1 shows the symptoms of faults that may occur in a power transformer. Complete the table.

Table 1

Symptom	Possible cause	Remedy
Transformer operating at high temperature	Overloading	Avoid overloading of the transformer
Condensation in control cabinet	Short circuit	Replacement of the device
Drain or fill valve plug leaking	Loose connection	replace + screw tightening of the valve
Oil level gauge on oil pump not reading full flow; unit hot	Clogging of the oil due to dust	Flush the pump or unclogge

(8 marks)

5. (a) (i) Define each of the following equipment failures:

I. misuse failure;
II. sudden failure.

(ii) Sketch the cost against reliability curves and explain their shape. (9 marks)

(b) List **three** factors that affect the mean time to repair (MTTR) an equipment.

(i) Time
(ii) cost of repair
(iii) Distance to repair

(3 marks)

(c) An electronic equipment fails 3 times after each time of 98 hours, 112 hours and 60 hours respectively. If the MTTR of the equipment is 35 hours, determine the:

(i) mean time between failure (MTBF);
(ii) failure rate;
(iii) availability;
(iv) unavailability.

(8 marks)

SECTION B: ANALOGUE ELECTRONICS I

*Answer any **TWO** questions from this section.*

(a) State **two**

(i) ways by which an electron may be excited;
(ii) Bohr's postulates.

(i) Through application of heat
(ii) Through direct incident reaction by

(4 marks)

(b) Explain the formation of space charge around the cathode of a thermionic valve.

(4 marks)

2521/105, 2602/106
2601/106, 2603/106
ELECTRICAL MEASUREMENTS AND
ANALOGUE ELECTRONICS I
June/July 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING
(POWER OPTION)
(TELECOMMUNICATION OPTION)
(INSTRUMENTATION OPTION)
MODULE I

ELECTRICAL MEASUREMENTS AND ANALOGUE ELECTRONICS I

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Mathematical table/Non-programmable scientific calculator;
Drawing instruments.
*The paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer any **THREE** questions from section **A** and any **TWO** questions from section **B** in the answer booklet provided.*
All questions carry equal marks.
Maximum marks for each part of the question are as indicated.
Candidates should answer the questions in English.

This paper consists of 6 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A: ELECTRICAL MEASUREMENTS

*Answer any **THREE** questions from this section.*

1. (a) With the aid of a labelled diagram and waveform, describe the measurement of the modulation index of an amplitude modulated signal using an oscilloscope with the internal timebase switched off. (6 marks)

(b) Figure 1 shows a circuit diagram illustrating the two-wattmeter method of 3-phase power measurement. Assuming a balanced load:

(i) draw the phasor diagram;

(ii) show that the total power is given by the expression $p = \sqrt{3}\, V_L . I_L \cos\phi$, where V_L and I_L are r.m.s values of line voltage and current, $\cos\phi$ is the load power factor. (8 marks)

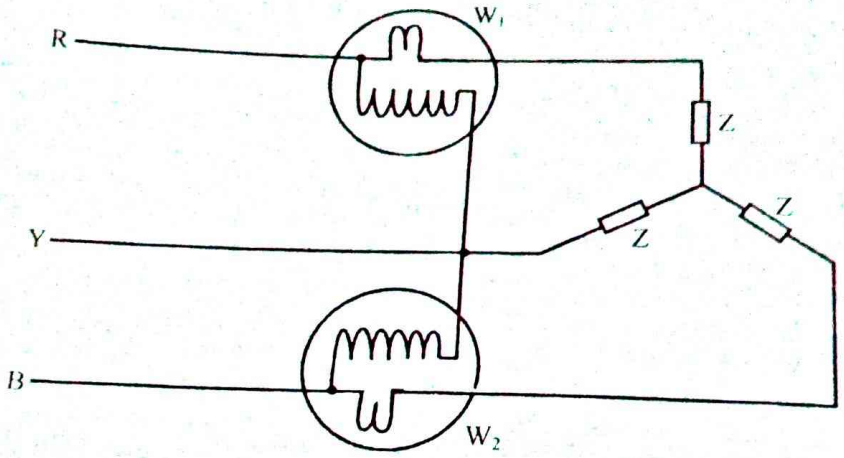


Fig. 1

(c) A voltmeter having a range of 0V to 300 V has a guaranteed accuracy of 1.5 percent of full scale reading. The voltage measured by the voltmeter is 195 V. Determine the:

(i) magnitude of the limiting error;

(ii) relative error at the measured voltage;

(iii) limiting values of the measured voltage. (6 marks)

2. (a) (i) State **three** factors that affect precision resistance measurement by the wheatstone bridge method.

(ii) With the aid of a labelled diagram, describe the measurement of inductance of a coil using Q-meter. (9 marks)

2521/105 2602/106
2601/106 2603/106
ELECTRICAL MEASUREMENTS AND
ANALOGUE ELECTRONICS I
Oct./Nov. 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING
(POWER OPTION)
(TELECOMMUNICATION OPTION)
(INSTRUMENTATION OPTION)

MODULE I

ELECTRICAL MEASUREMENTS AND ANALOGUE ELECTRONICS I

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Non-programmable Scientific calculator.
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer any **THREE** questions from section **A** and any **TWO** questions from section **B**.*
All questions carry equal marks.
Maximum marks for each part of the question are as indicated.
Candidates should answer questions in English.

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SECTION A: ELECTRICAL MEASUREMENTS

*Answer any **THREE** questions from this section.*

1. (a) (i) State **three** errors that can occur in electrical measurement systems.

(ii) With the aid of a labelled diagram, describe the operation of a multicellular-type electrostatic voltmeter.

(9 marks)

(b) A multi range d.c milliammeter has an internal resistance of 50 Ω. A current of 2 mA gives full scale deflection on the meter. The meter has current ranges of 0 -10 mA, 0 - 50 mA, 0 - 100 mA and 0 - 500 mA. Determine the value of the shunt resistor for each range.

(7 marks)

(c) (i) Sketch a labelled waveform of an amplitude modulated wave displayed on an oscilloscope.

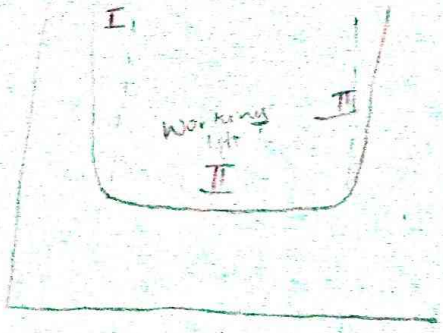
(ii) From the display in c (i), state the expression for the modulation index.

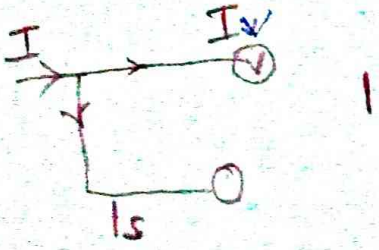
(4 marks)

a) (i) Distinguish between sudden failure and complete failure.

(ii) With the aid of a failure rate versus time curve, describe the performance of an equipment from the time it is put into use up to the end of its life.

(8 marks)





(b) Table 1 shows the failure rate, quantity and weighting factors for components used in an electronic equipment. For the equipment, determine the:

(i) failure rate;
(ii) mean time between failure;
(iii) reliability for an operating period of 1,000 hours. (10 marks)

Table 1

Component	Failure rate (λ) percent per 1000 hours	Quantity (n)	Weighting Factor (w)
Transistors	0.01	50	1.5
Diodes	0.01	100	1.0
Composition resistors	0.005	80	1.0
Ceramic capacitors	0.025	30	1.0
Electrolytic capacitors	0.2	20	3.0
Film resistors	0.1	40	1.5
Inductors	0.05	15	1.5

(c) State **two** effects of humidity on an equipment. (2 marks)

(a) (i) State **two** faults that can be revealed by visual inspection.

(ii) Describe reflow soldering method.

(6 marks)

(b) The voltage gain of an audio frequency (AF) amplifier that has been repaired is to be tested. You have been provided with an AF signal generator, oscilloscope, switched attenuator, dummy load and the amplifier under test.

(i) Draw a labelled block diagram for the set-up.

(ii) Outline the procedure for the test.

(8 marks)

(c) (i) Draw a diagram illustrating how a multimeter is used to test a P-N diode.

(ii) Describe how the test in c (i) is carried out.

(6 marks

4. (a) State the units for each of the following electrical quantities:

(i) magnetic field strength;

(ii) quantity of electricity;

(iii) magnetomotive force.

(3 marks)

(b) Derive, from first principles, the dimensional equation for the pole strength in the c.g.s. electromagnetic units.

(8 marks)

(c) Describe "standard" as used in measurements.

(4 marks)

(d) Derive the dimensional equation for mechanical energy.

(5 marks)

5. (a) Explain the reason for performing the following during routine maintenance:

(i) lubrication;
(ii) cleaning;
(iii) re-alignment.

(6 marks)

(b) (i) State **two** assumptions to be made in the half-split method of locating a fault.

(ii) Describe the following phases of corrective maintenance tasks:

(I) fault detection;
(II) fault location.

(6 marks)

(c) A ballistic galvanometer has a coil of 120 turns with a mean area of 900 mm^2. The flux density in the airgap is 0.18 Wb/m^2. Taking the moment of inertia as 0.55×10^{-6} kg m^2 and stiffness as 47×10^{-6} Nm/rad, determine the:

(i) displacement constant;
(ii) current to give a deflection of 120°;
(iii) damping constant;
(iv) value of resistor to be added in series to give critical damping.

(8 mark

SECTION B: ANALOGUE ELECTRONICS I

*Answer any **TWO** questions from this section.*

6. (a) (i) Define the following with respect to semiconductors:

(I) covalent bond;
(II) drift current.

(ii) With the aid of a labelled diagram, describe the formation of a p-type semiconductor. (9 marks)

(b) Explain Rutherford's atomic structure. (4 marks)

(c) (i) State **three** parameters used to describe semiconductor diode specifications.

(ii) Sketch a labelled voltage-current characteristic curve of the diode in c (i). (7 marks)

7. (a) Figure 1 shows a circuit diagram of a depletion MOSFET amplifier. The MOSFET has a drain saturation current of 4 mA and a pinchoff voltage of $-5V$. Determine the:

(i) gate bias voltage, V_G;
(ii) gate-to-source voltage, V_{GS};
(iii) drain current, I_D;
(iv) drain voltage; V_D. (8 marks)

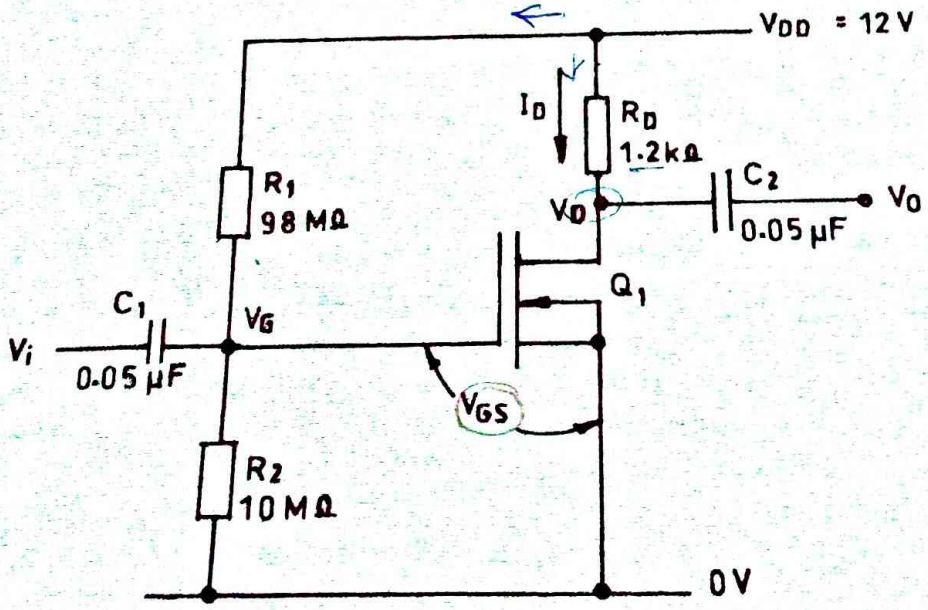


Fig. 1

(b) Derive the expression for the common-base current gain, α, in terms of the common-emitter current gain, β. (6 marks)

(c) (i) State the **three** operating regions of a transistor.

(ii) Draw the circuit diagram of the common-collector configuration of a transistor amplifier. (6 marks)

8. (a) Explain the function of the following parts of a cathode-ray oscilloscope:

(i) time base generator;
(ii) trigger pulse generator;
(iii) Y-amplifier. (6 marks)

(b) An electrostatic CRT has a final anode voltage of 2000 V and parallel deflecting plates 1.5 cm long. Taking electronic charge, $e = 1.6 \times 10^{-19}$C and mass of electron, $m = 9.1 \times 10^{-31}$ kg, determine the following for an electron emitted from the cathode:

(i) maximum velocity;
(ii) transit time through the deflecting plates;
(iii) kinetic energy. (6 marks)

(c) (i) State the properties of capacitors that make them suitable for use as power supply filters.

(ii) With the aid of a circuit diagram, describe the operation of a zener diode voltage regulator. (8 marks)

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