

## ANALOGUE ELECTRONICS II

**UNIT CODE:** 0714441 11A

**TVET CDACC UNIT CODE:** ENG/CU/MDE/CC/10/5/MA

**UNIT DURATION:** 70 HOURS

### Relationship to Occupational Standards

This unit addresses the unit of competency: Analogue Electronics II.

### UNIT DESCRIPTION

This unit covers the competencies required in applying analogue electronics. It involves building amplifier circuits, constructing signal generators, constructing signal filter circuits and applying opto-electronics.

### Summary of Learning Outcomes

S/No.	Learning Outcome	Duration in hours.
1.	To build amplifier circuits	20
2.	To construct signal generators	20
3.	To construct signal filter circuits	20
4.	Apply Opto-Electronics	10
	<b>TOTAL</b>	<b>70</b>

### Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Build amplifier circuits	1.1 Introduction to transistors 1.1.1. BJT transistors (NPN & PNP) 1.1.2. FET transistors (JFET & MOSFETs) 1.1.3. BJT transistors configurations 1.1.4. Biasing techniques	<ul style="list-style-type: none"><li>• Practical Assessment</li><li>• Project</li><li>• Third Party Report</li><li>• Portfolio of Evidence</li><li>• Written Assessment</li><li>• Oral Questioning</li></ul>

Learning Outcome	Content	Suggested Assessment Methods
	<ul style="list-style-type: none"> <li>1.1.5. Transistor rating/limits</li> <li>1.1.6. BJT and FET transistor applications</li> <li>1.1.7. Amplifier Circuits               <ul style="list-style-type: none"> <li>1.1.7.1. Operational amplifiers</li> <li>1.1.7.2. Classical amplifier</li> </ul> </li> <li>1.1.8. Opamps</li> <li>1.1.9. Amplifier ICs:               <ul style="list-style-type: none"> <li>1.1.9.1. Common amplifier IC families, i.e., TDA, LM, LA series.</li> <li>1.1.9.2. Benefits of ICs compared to discrete component amplifiers.</li> </ul> </li> <li>1.2 Assemble components, tools and equipment for amplifier circuit construction</li> <li>1.3 Construct amplifier circuits               <ul style="list-style-type: none"> <li>1.3.1. Single-stage CE amplifier</li> <li>1.3.2. Two-stage amplifier</li> <li>1.3.3. Op-Amp inverting and non-inverting amplifiers</li> <li>1.3.4. Simple audio amplifiers using amplifier ICs</li> <li>1.3.5. DC motor control</li> </ul> </li> <li>1.4 Test amplifier circuits               <ul style="list-style-type: none"> <li>1.4.1. Measure voltage and current flow</li> <li>1.4.2. Observe input and output voltage waveforms</li> <li>1.4.3. Check for distortion</li> </ul> </li> </ul>	

Learning Outcome	Content	Suggested Assessment Methods
	1.4.4. Confirm continuity and polarity using a multimeter	
2. Construct signal generators	<p>2.1.Introduction to:</p> <p>2.1.1 Oscillators</p> <p>2.1.2 Crystal oscillator (radio frequency generator)</p> <p>2.1.3 Multivibrator circuits – bistable &amp; astable (pulse generators)</p> <p>2.1.4 Function generator</p> <p>2.2.Assemble components, tools and equipment to construct signal generators</p> <p>2.2.1 Assemble breadboards, resistors, capacitors, inductors, multimeters, power supplies, oscilloscopes,</p> <p>2.3.Signal generator circuits</p> <p>2.3.1 Function generator</p> <p>2.3.2 Radio Frequency generator</p> <p>2.3.3 Audio signal generator</p> <p>2.3.4 Pulse generator</p> <p>2.4.Construct signal generator circuits</p> <p>2.4.1 RC oscillator (sine waves)</p> <p>2.4.2 Astable multivibrator (square waves)</p> <p>2.4.3 Bistable multivibrator (square waves)</p> <p>2.4.4 Generate waveforms using the function generator</p> <p>2.4.5 Clock generator using the crystal oscillator</p>	<ul style="list-style-type: none"> <li>• Practical Assessment</li> <li>• Project</li> <li>• Third Party Report</li> <li>• Portfolio of Evidence</li> <li>• Written Assessment</li> <li>• Oral Questioning</li> </ul>

Learning Outcome	Content	Suggested Assessment Methods
	2.4.6 Audio frequency Opamp generator 2.5. Test signal generator circuits 2.5.1 Measure voltage, current, and display waveforms 2.5.2 Record the amplitude, frequency, and period	
3. Construct signal filter circuits	3.1 Introduction to types of filters 3.1.1. Passive Filters, i.e., RC, RL, and LC filters. 3.1.2. Active Filters, i.e., op-amp-based filters (low-pass, high-pass, band-pass, band-stop). 3.2 Assemble components, tools and equipment to build signal filter circuits 3.2.1. resistors, capacitors, op-amps, breadboards, jumper wires, power supplies, multimeters and oscilloscopes. 3.3 Construct signal filter circuits; 3.3.1 Low-pass filter circuit 3.3.2 High-pass filter circuit 3.3.3 Band-pass filter circuit 3.4 Test signal filter circuits 3.4.1. Measure the output waveform 3.4.2. Verify the filter passes or blocks the correct frequency range. 3.4.3. Measure the cut-off frequency to match circuit specification.	<ul style="list-style-type: none"> <li>• Practical Assessment</li> <li>• Project</li> <li>• Third Party Report</li> <li>• Portfolio of Evidence</li> <li>• Written Assessment</li> <li>• Oral Questioning</li> </ul>

Learning Outcome	Content	Suggested Assessment Methods
4. Apply opto-electronics	4.1 Opto-electronic devices 4.1.1 LEDs 4.1.2 OLED 4.1.3 LASER diode 4.1.4 Photo transistors 4.1.5 Photo diodes 4.1.6 Optocoupler 4.1.7 LASCR 4.2 Liquid crystal displays 4.2.1 Dynamic scattering LCDs 4.2.2 Field effect scattering LCDs 4.3 LASERs and MASERs 4.4 Applications of optoelectronics	<ul style="list-style-type: none"> <li>• Practical Assessment</li> <li>• Project</li> <li>• Third Party Report</li> <li>• Portfolio of Evidence</li> <li>• Written Assessment</li> <li>• Oral Questioning</li> </ul>

#### Suggested Methods of Instruction

- Practical
- Projects
- Demonstrations
- Group Discussions
- Role Play
- Interactive lectures
- Individual Assignments
- Industrial Attachments
- Viewing of Related Videos
- Clinical and Hospital Trips

### Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	Learning Materials			
1.	Reference books	<p>Mehta, V. K., &amp; Mehta, R. (2020). Principles of electronics (12 edition). S. Chand and Company Limited, Theraja, B. L., &amp; Theraja, A. K. (2005). A textbook of electrical technology (1st multicolour ed., Multicolour illustrative ed., 23rd rev. multicoloured ed). S. Chand &amp; Co.</p> <p>Bird, J. O. (2022). Bird's electrical and electronic principles and technology (Seventh edition). Routledge, Taylor &amp; Francis Group.</p> <p>Wilcher, D. (2015). Arduino electronics blueprints: make common electronic devices interact with an Arduino board to build amazing out-of-the-box projects. Packt Publishing.</p> <p>Maini, A. K. (2008). Digital electronics: principles,</p>	10 pcs for each	1:2.5

		devices and applications. Wiley India.		
2.	Software	Assorted simulation software e.g., Circuit wizard, Proteus, Multisim.	25	1:1
3	Audio visual presentations	Projector	1	1:25
<b>B</b>	<b>Learning Facilities &amp; Infrastructure</b>			
4	Lecture/theory room	60m <sup>2</sup>	1	1:25
5	Workshop	150m <sup>2</sup>	1	1:25
6	Computer laboratory	100m <sup>2</sup>	1	1:25
<b>C</b>	<b>Consumable Materials</b>			
7	Resistors 1/4W rating	1 $\Omega$ , 2.2 $\Omega$ , 3.3 $\Omega$ , 10 $\Omega$ , 22 $\Omega$ , 47 $\Omega$ , 68 $\Omega$ , 100 $\Omega$ , 120 $\Omega$ , 150 $\Omega$ , 220 $\Omega$ , 330 $\Omega$ , 470 $\Omega$ , 560 $\Omega$ , 680 $\Omega$ , 1 k $\Omega$ , 1.2 k $\Omega$ , 2k $\Omega$ , 3.3 k $\Omega$ , 4.7 k $\Omega$ , 5.6k $\Omega$ , 10 k $\Omega$ , 22 k $\Omega$ , 33 k $\Omega$ , 47 k $\Omega$ , 100 k $\Omega$ , 220 k $\Omega$ , 330 k $\Omega$ , 470 k $\Omega$ , 1 M $\Omega$ , 2.2 M $\Omega$	100 pcs for each	4:1
8	Potentiometers	1 k $\Omega$ , 10 k $\Omega$ , 50 k $\Omega$ , 100 k $\Omega$	50 pcs for each	2:1
9	Polarised electrolytic capacitors	1 $\mu$ F(16V, 25V, 50V), 4.7 $\mu$ F(16V, 25V, 50V), 10 $\mu$ F(16V, 25V, 50V, 63V), 22 $\mu$ F(16V, 25V, 50V), 33 $\mu$ F(25V, 35V, 50V), 47 $\mu$ F(16V, 25V, 50V), 100 $\mu$ F(16V, 25V, 35V, 50V), 220 $\mu$ F(25V, 35V, 50V, 63V)	50 pcs for each	2:1

		<b>470μF</b> (16V, 25V, 35V, 50V) <b>1000μF</b> (16V, 25V, 35V, 50V), <b>2200μF</b> (25V, 35V, 50V), <b>4700μF</b> (25V, 35V, 50V)		
10	Ceramic capacitors assortment kit 10pf to 100nF (non-polarized)	<b>10pF</b> (100), <b>20pF</b> (200), <b>30pF</b> (300), <b>47pF</b> (470), <b>56pF</b> (560), <b>68pF</b> (680), <b>100pF</b> (101), <b>220pF</b> (221), <b>330pF</b> (331), <b>680pF</b> (681), <b>1nF</b> (102), <b>4.7nF</b> (472), <b>10nF</b> (101), <b>47nF</b> (471), <b>100nF</b> (104)	50 pcs for each	2:1
11	Polyester film capacitor assortment kit - 0.22nF to 470nF / 100V (non-polarised)	<b>0.22nF</b> (221), <b>0.33nF</b> (331), <b>0.47nF</b> (471), <b>0.56nF</b> (561), <b>0.68nF</b> (681), <b>1nF</b> (102), <b>2.2nF</b> (222), <b>2.7nF</b> (272), <b>3.3nF</b> (332), <b>3.9nF</b> (392), <b>4.7nF</b> (472), <b>6.8nF</b> (682), <b>10nF</b> (103), <b>15nF</b> (153), <b>22nF</b> (223), <b>33nF</b> (333), <b>39nF</b> (393), <b>47nF</b> (473), <b>68nF</b> (683), <b>82nF</b> (823), <b>100nF</b> (104), <b>150nF</b> (154), <b>220nF</b> (224), <b>470nF</b> (474)	50 pcs for each	2:1
12	Transformer	120-240Vac, 12V-0-12V, 2A, 50Hz	25 pcs for each	1:1
13	Rectifier diode	1N4001, 1N4002.	25 pcs for each	2:1
14	Zener diodes 0.5W	5.1V, 7.5V, 12V, 18V, 24V	25 pcs for each	1:1
15	Voltage regulators	L7805, L7809, L7812, L7815,	25 pcs for each	1:1



		L7824, L7905, L7912,		
16	MOSFET	IRFZ44N, IRF520, IRF540	25 pcs for each	1:1
17	Assorted colours of light emitting diodes (LEDs)	3mm, 5mm	500 pieces for each	20:1
18	Schottky diode	IN5817, IN5819	10 pcs for each	1:3
19	Strip boards	Stripboard 6.5cm x 14.5cm Single Sided	50 pieces	2:1
20	Solder wire	1mm-diameter, rosin activated, lead free soldering wire 50g	2 pcs for each	1:13
21	Flux	Soldering paste flux 150g	2 pcs for each	1:13
22	DIP IC sockets		100 pieces	4:1
23	Assorted jumper wires (soft) for stripboard	Red, blue, green, yellow, black	50 m for each	2:1
24	Assorted jumper wire (hard) for breadboard	Red, blue, green, black	50 m for each	2:1
25	Audio connector jack pin		50 pcs	2:1
26	Audio speaker		25 pcs	1:1
27	Female - DC power connector		25 pcs	1:1
28	Solder wire			
29	Crocodile/ alligator clips	50cm Test Leads Alligator Clips Double-end	25 pcs for each	1:1
30	555 Timer	NE555 IC DIP-8	25 pcs	1:1
31	Arduino 8-Bit Processor chip	Atmel's ATmega328P	25 pcs	1:1

32	Arduino board	Arduino Uno R3 (with removable IC Chip) complete with USB Cable	25 pcs	1:1
33	LCD display	LCD 20X4 (2004)	25 pcs	1:1
34	Assorted jumpers with connector pins	M-M jumpers, M-F jumpers, F-F jumpers	200 pcs for each	8:1
35	PIR Motion sensor module		10 pcs	1:3
35	BJT (NPN) transistor	BC547, BC108, 2N3904, 2N2222, TIP31,	50 pcs for each	2:1
36	BJT (PNP) transistor	BC557, 2N3906, 2N2907, TIP32,	25 pcs for each	1:1
37	Light Dependent Resistor	LDR 12mm	25 pcs	1:1
38	OPAMPs	LM358, LM741	25 pcs for each	1:1
39	Audio amplifier ICs	TDA2030, LM386, LA4445, LA4440	25 pcs for each	1:1
40	74 series logic gates - TTL Logic	7400, 7402, 7404, 7408, 7432,	25 pcs for each	1:1
41	4000-series CMOS ICs	CD4011, CD4013, CD4027, CD4026, CD4047, CD4060, CD4051, CD4052, CD4093	25 pcs for each	1:1
42	74 series ICs	74LS74, 74LS76, 74LS86, 74LS90, 74LS138, 74LS145, 74LS151, 74LS153 ICs	25 pcs for each	1:1
43	SPDT Relay (125-250Vac)	5V DC SPDT Relay, 12V DC SPDT Relay.	25 pcs for each	1:1
44	Multi-channel Relay Module	5V DC 4-Channel Relay, 12V DC 4-Channel Relay	25 pcs for each	1:1

	(125-250Vac)			
45	Push button non-self-locking	mini-switch	25	1:1
46	Push button self-locking	mini-switch	25	1:1
47	Slide switch SPDT 3 pins	mini-switch	25	1:1
48	DC motor	DC 3V-6V 2000RPM R140 motor	10 pcs	1:3
49	NTC Thermistors	10k $\Omega$ , 100k $\Omega$	25 pcs for each	1:1
50	Temperature sensor	Digital temperature sensor	25	1:1
51	Fluid level sensor	eTape Liquid Level Sensors	2 pcs	1:13
52	Soil Moisture Sensor		5 pcs	1:5
53	IR (infrared) sensor module		13 pcs	1:2
54	Ultrasonic Sensor		13 pcs	1:2
55	Temperature and Humidity Sensor		13 pcs	1:2
56	Water Level Sensor Float Switch		5 pcs	1:5
<b>D</b>	<b>Tools &amp; Equipment</b>			
57	Computers		25 pcs	1:1
58	Bread boards		25 pcs	1:1
59	Assorted tools	Side cutters, Pliers, crimping, Tweezers, Long-nose, Assorted screw drivers.	25 pcs for each	1:1
60	Solder gun/iron	Solder gun/iron 15W - 30W,	25 pcs for each	1:1

		Solder gun/iron 40W - 60W,		
61	Solder tip cleaning wire and holder		25 pcs for each	1:1
62	Solder sucker		25 pcs	1:1
63	Digital Oscilloscope,		5 pcs	1:5
64	Digital Multimeter		25 pcs	1:1
65	Digital functional generator		5 pcs	1:5
66	Laser jet printer		2 pcs	1:13
67	Variable power supply	With option for both voltage and current adjustment	5 pcs	1:5
68	Power adapters	5V Power adapters 9V Power adapters 12V Power adapters.	10 pcs for each	1:3
69	Trainers kit	Analogue training kits, Digital training kits,	5 pcs for each	1:5
70	PCB prototyping material	Copper board, ferrite chloride solution, see-through printing paper, HASL finishing PCB	25 pcs for each	1:1
71	Drilling gun		3 pcs	1:8
72	Work stations		25	1:1
<b>D</b>	<b>Software</b>			
73	Arduino IDE		Installed in 25 computers	1:1
74	Simulation software	Circuit wizard/Multisim/Proteus	Installed in 25 computers	1:1