

The following section has been inserted under ITB 2 as sub section 2.5

Only those bidders are eligible to participate in this tender who do not have a past history of litigation/open investigation/substandard supply/incomplete supply/ fraudulent supply with UET Peshawar

7. UPDATED BILL OF QUANTITIES OF ITEMS AND TECHNICAL SPECIFICATIONS

Electrical Engineering Department

1) CIRCUITS LAB - BASIC ELECTRICAL & ELECTRONIC TECHNOLOGY PART 1 (Lot Wise Only – Import Purchase)

Imported items must be; of advanced technological countries i.e. UK, USA, Japan and Western European Countries

S.No	Equipment Name and Specification	Qty
14	Magnetism/electromagnetism Training Card for the PC interfaced hardware	8
16	Electrical network analysis Training Card for the PC interfaced hardware	8
22	Circuit design using NI Multisim Training Kit for the PC interfaced hardware	8
23	PCB layout with NI Ultiboard Training software	1
24	PC Interfaced hardware with virtual instruments (Voltmeter, Ammeter, Multi meter, 2 channel oscilloscope, Function generator etc.)	8
25	PC Interface Experiment work Area to accommodate training cards and/or breadboards for experimenting	8
26	PC Interfaced hardware measurement accessories, shunts and connection cables	8
30	DC technology training kit 2mm/4mm plugin system comprising of the following components with gold plating at the connection point as that improves conductivity and protects the component: <ul style="list-style-type: none">• Red LED• Green LED• Incandescent lamp• NPN transistor BC547• Button• 100 μF capacitors• 470 μF capacitors• Switch• 22 Ω resistor• 100 Ω resistor• 220 Ω resistor• 470 Ω resistor• 1k Ω resistor• 2.2k Ω resistor• 10k Ω resistor• 22k Ω resistor• 47k Ω resistor• 100k Ω resistor• 1M Ω resistor	8

	<ul style="list-style-type: none"> • VDR resistor • LDR resistor • NTC resistor • PTC resistor • Relay 	
31	<p>AC and three-phase technology training kit 2mm/4mm plugin system comprising of the following components with gold plating at the connection point as that improves conductivity and protects the component:</p> <ul style="list-style-type: none"> • 10 mH inductor • 33 mH inductor • 1 μF capacitor • 0.47 μF capacitor • 10 Ω resistor • 22 Ω resistor • 33 Ω resistor • 100 Ω resistor • 220 Ω resistor • 680 Ω resistor • 1 k Ω resistor • 2,2 k Ω resistor • Red LED • Green LED • Button • C-core Coil 	8
32	<p>Semiconductor Components training kit 2mm/4mm plugin system comprising of the following components with gold plating at the connection point as that improves conductivity and protects the component:</p> <ul style="list-style-type: none"> • Triac • Diac • Push button • 33 Ω resistor • 100 Ω resistor • 220 Ω resistor • 330 Ω resistor • 470 Ω resistor • 1 kΩ resistor • 2.2 kΩ resistor • 4.7 kΩ resistor • 10 kΩ resistor • 22 kΩ resistor • 100 kΩ resistor • Diodes, 1N4007 • Germanium diode, AA113 • Zener diode, 4.7 V • Zener diode, 10 V • 1kΩ Potentiometer • 10 kΩ Potentiometer • Transistor, BC547, base left • Transistor, BD237, base left • Field effect transistor, J112 • 0.1 μF capacitor • 0.22 μF capacitor • 0.47 μF capacitor • 1 μF capacitor 	8

	<ul style="list-style-type: none"> • 10 μF electrolytic capacitor • MOSFET BS170 • Thyristor • Switch • Red LED • Green LED 	
33	<p>Basic Electronics Circuits training kit 2mm/4mm plugin system comprising of the following components with gold plating at the connection point as that improves conductivity and protects the component::</p> <ul style="list-style-type: none"> • 1 pair cut strip-wound core • 10 mH coil • 33 mH coil • Transformer coil N = 300 • Transformer coils N = 900 • film resistors from 10 Ω ... 1 M Ω range • potentiometer 1 k Ω • potentiometer 10 k Ω • LED • field effect transistor J112 • Transistor BD238 base right • Transistor BC547 base right • Transistors BC547 base left • Transistors BD237 base right • Transistors BD237 base left • Uni-junction transistor • DIAC • Thyristor • TRIAC • Silicon diodes 1N4007 • Zener diode 4.7 V • germanium diode AA113 • operational amplifier • capacitors from 47 pF ... 1 μF range • electrolyte capacitors from 10 μF ... 470 μF range • incandescent lamp • speaker 	8
34	<p>Opto Electronics Circuits training kit 2mm/4mm plugin system comprising of the following components with gold plating at the connection point as that improves conductivity and protects the component:</p> <ul style="list-style-type: none"> • Silicon photodiode • Silicon phototransistor • Silicon photo element • LED • Infrared LED • speaker • pushbutton • Base Left transistor BC547 • Film resistors from 100 Ω ...22 kΩ range • 10 μF capacitor • incandescent lamp • Opto Coupler • optical waveguide housings • fibre optic waveguide 	8
35	Experimenter training kit 2mm/4mm plugin system, 60 or more nodes	8

	for inserting the plug-in modules	
36	set of connection cables and plugs for 2mm system	8
38	Analog multimeter AC 300V/3A, DC 300V/10A	8
39	Lab multimeter with IR interface. 3 ½ digit multimeter resolution: ±3000 digits Voltage measuring ranges: 30 mV-1000 V DC, 3 V-1000 V AC; current measuring ranges: 3 mA-16 A DC; 30 mA-10 A AC Resistance ranges: 30Ω to 30 MΩ Bar Chart Display Backlighting	8
40	Digital dual trace storage oscilloscope w. colour display, incl. probes 30MHz or greater	8
41	Sweep Function generator 40MHz - 20MHz with frequency counter	8
42	Multi Power Supply 4x DC, 2x AC, 3-phase, function generator	8
	Instructor Workstation	
43	table with sliding top, approximately 6ft wide x 3ft deep	1
44	PC holder for table	1
45	Under the table cabinet with wheels having minimum three drawers, a utensil drawer with central locking	1
	Work Station for the Trainee	
50	table with sliding top, approximately 6ft wide x 3ft deep with two (2) special Lab rotating chair with moulded texture, varnished in natural colours, continuous height adjustment by means of a gas lift mechanism with top release, non-tipping aluminum base with epoxy- resin coating	8
51	PC holder for table	8
	Storage Facilities	
57	Open Shelf cabinet to accommodate PC Interfaced courses	2
58	Storage cabinet with 2 hinged door approximately 3ft wide, 2 ft deep and 6 ½ feet height	2
59	Appropriately sized Shelf for storage cabinet at item 58	10

2. CIRCUITS LAB - DIGITAL TECHNOLOGY AND EMBEDDED SYSTEM PART 2

(Lot Wise Only – Import Purchase):

Imported items must be; of advanced technological countries i.e. UK, USA, Japan and Western European Countries

S.No	Equipment Name and Specification	Qty
1	PC Interfaced hardware with virtual instruments (Voltmeter, Ammeter, Multi meter, 2 channel oscilloscope, Function generator etc.)	8
12	Introduction to Digital Technology 2mm/4mm plug-in system comprising of the following components with gold plating at the connection point as that improves conductivity and protects the component: <ul style="list-style-type: none"> • AND/NAND gates, 4 inputs, 2-fold • AND/NAND gate, 2 inputs, 4-fold • OR/NOR gates, 4 inputs, 2-fold • OR/NOR gate, 2 inputs, 4-fold • XOR/XNOR gate, 2 inputs, 4-fold • 4-bit buffer/NOT gate • 4-bit adder • JK flip-flop, 2-fold • JK master-slave flip-flop, 2-fold • monoflop, 2-fold 	8
13	Sequential Circuits 2mm/4mm plug-in system comprising of the following components with gold plating at the connection point as that improves conductivity and protects the component: <ul style="list-style-type: none"> • Shift register, 4-bit, 2-fold • Counter, 4-bit • Clock generator • AND/NAND gate, 2 inputs, 4-fold • XOR/XNOR gate, 2 inputs, 4-fold • AND/OR/NOT gates • 4-bit buffer/NOT gate • buffer, 4-bit, tri-state • JK flip-flop, 2-fold • 7-segment display • 1 from 4 Multiplexer 	8
14	Experimenter connecting to main 2mm/4mm system, 60 or more nodes for inserting the plug-in modules	8
15	set of connection cables and plugs for 2mm system	8
17	Analog multimeter AC 300V/3A, DC 300V/10A	8
18	Lab multimeter with IR interface. 3 ½ digit multimeter resolution: ±3000 digits Voltage measuring ranges: 30 mV-1000 V DC, 3 V-1000 V AC; current measuring ranges: 3 mA-16 A DC; 30 mA-10 A AC Resistance ranges: 30Ω to 30 MΩ Bar Chart Display Backlighting	8
19	Digital dual trace storage oscilloscope w. colour display, incl. probes 30MHz or greater	8
20	Sweep Function generator 40mHz - 20MHz with frequency counter	8
21	Multi Power Supply 4x DC, 2x AC, 3-phase, function generator	8
	Instructor Workstation	

23	table with sliding top, approximately 6ft wide x 3ft deep	1
24	PC holder for table	1
25	Under the table cabinet with wheels having minimum three drawers, a utensil drawer with central locking	1
	Work Station for the Trainee	
31	table with sliding top, approximately 6ft wide x 3ft with two (2) special Lab rotating chair with moulded texture, varnished in natural colours, continuous height adjustment by means of a gas lift mechanism with top release, non-tipping aluminium base with epoxy-resin coating	8
32	PC holder for table	8
	Storage Facilities	
41	Storage cabinet with 2 hinged door approximately 3ft wide, 2 ft deep and 6 ½ feet height	2
42	Appropriately sized Shelf for the storage cabinet at item 41	8

**3. POWER ENGINEERING AND ALTERNATIVE ENERGY LABORATORY
PART-1 (Lot Wise Only- Import Purchase):**

Imported items must be; of advanced technological countries i.e. UK, USA, Japan and Western European Countries

S.No	Equipment Name and Specification	Qty
	Fundamentals of Power Systems Engineering	
1	PC Interfaced hardware with virtual instruments (Voltmeter, Ammeter, Multi meter, 2 channel oscilloscope, Function generator etc.)	8
2	PC Interface Experiment work Area to accommodate training cards and/or breadboards for experimenting	8
3	PC Interfaced hardware measurement accessories, shunts and connection cables	8
7	Photovoltaic Training Kit for the PC Interfaced system	8
8	Fuel cell technology Training Kit for the PC Interfaced system	8
9	Transient processes in AC and DC networks Training Cards for the PC Interfaced system	8
	SCADA controlled workstations for Power Engineering:	
	Power Generation	
10	Synchronization Unit	1
11	Three-phase synchronous machine with smooth core rotor, 1kW	1
12	Multi-function relay, power controller, cos-phi controller, synchronizing unit	1
13	Human Machine Interface for generators	1
15	Power switch module	1
16	Variable Ohmic load, three-phase, 1kW	1
17	Inductive load, three-phase, 1kW	1
18	Pumped-Storage power station Training Software	1
19	Servo machine test bench for 1kW machines with controlling software	1
20	Rubber coupling sleeve, 1kW	1
21	Coupling guard, 1kW	1
22	Shaft end guard, 1kW	1

24	Mains Synchronisation and Automatic Generator Control Training Software	1
25	Transformer / Generator differential protection relay	1
26	Rotor-earth fault relay	1
	<u>Media:</u>	
27	Generator protection Training Software	1
28	interface converter cable USB/RS485	1
30	USB Network Adapter 10/100 BaseTX RJ45	1
	<u>Power supply:</u>	
33	Universal power supply for DC and Three-Phase Current	1
34	Exciter voltage controller with de-excitation	1
35	Motor protection switch, 3 pole	1
36	Multiple socket outlet, 5 fold	1
	<u>Measuring instruments:</u>	
37	Three Phase Power Quality Meter with display and long-term memory	1
38	Power Meter	1
	<u>Accessories:</u>	
39 - 42	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth	As required
43	Set of safety measurement cables, 4mm	1
	<u>Mobile Work Station</u>	
44	Mobile aluminum experiment stand, 3 levels with 6 earthed sockets or more	2
45	PC holder for experiment trolleys, height and width adjustable	2
46	Monitor holder for flat screen monitor	2
47	Keyboard and mouse platform for the experiment stand	2
48	Wall or aluminum-profile mounting cable storage	2
	<u>Wind Power Plants</u>	
49	Control unit for wind turbine double-fed asynchronous generator	1
50	Three-phase multi-function machine, 1.0 kW	1
51	3-phase isolation transformer, 1kW for wind power plants	1
52	Incremental position encoder 1024 pulses	1
53	Dynamic grid fault simulator	1
	<u>Machine test bench equipment set for servo-drive/braking system:</u>	
54	Servo machine test bench for 1kW machines with controlling software	1
55	Rubber coupling sleeve, 1kW	2
56	Coupling guard, 1kW	2
	<u>Power supply:</u>	
58	Three-Phase power supply with switch for motor protection	1
	<u>Measuring instruments:</u>	
59	Power Multimeter	1
	<u>Accessories:</u>	
61-64	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth	As required

65	Set of safety measurement cables, 4mm	1
	<u>Mobile Work Station</u>	
66	Mobile aluminum experiment stand, 3 levels with 6 earthed sockets or more	1
67	PC holder for experiment trolleys, height and width adjustable	1
68	Monitor holder for flat screen monitor	1
69	Keyboard and mouse platform for the experiment stand	1
70	Wall or aluminum-profile mounting cable storage	1
	<u>Photovoltaics</u>	
71	Solar module simulation model, 3-fold	1
72	Solar module with solar altitude emulator	1
73	Load unit 1kOhm, 500W	1
74	Solar charge controller	1
75	Solar Accumulator	1
76	Off-grid inverter 230V, 275VA	1
77	Lamp board 12V	1
78	Lamp board 230V	1
79	Industrial photovoltaics inverter	1
80	Energy monitor and a Power MultiMeter	1
81	Single-phase mains supply with switch, circuit breaker and earth-contact socket	1
82-86	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth	As required
87	Set of safety measurement cables, 4mm	1
88	Safety measurement cable (4mm), 50cm, red	4
89	Mobile aluminum experiment stand, 3 levels with 6 earthed sockets or more	1
91	Wall or aluminum-profile mounting cable storage	1
92	PC holder for experiment trolleys, height and width adjustable	1
93	Monitor holder for flat screen monitor	1
	<u>Accessories:</u>	
94	Safety connection plug 19mm/4mm, black	6
95	Safety measurement cable (4mm), 50cm, red	3
96	Safety measurement cable (4mm), 50cm, black	3
	<u>Mobile Work Station</u>	
97	Mobile aluminum experiment stand, 3 levels with 6 earthed sockets or more	1
98	PC holder for experiment trolleys, height and width adjustable	1
99	Monitor holder for flat screen monitor	1
100	Keyboard and mouse platform for the aluminum experiment stand	1
101	Wall or aluminium-profile mounting cable storage	1
	<u>Transformers</u>	
102	Multi-function transformer 1 kVA	1
103	Power switch module	1
104	Inductive load, three-phase, 1kW	1
105	Capacitive load, three-phase, 1kW	1

106	Variable Ohmic load, three-phase, 1kW	1
107	Training software for Transformers	1
109	USB Network Adapter 10/100 BaseTX RJ45	1
111	Transformer / Generator differential protection relay	1
112	Power switch module	2
113	Transmission line Model 150km/300km (93.2miles/186.4miles) or greater	1
114	Time Overcurrent Relay	1
115	Interface converter USB/RS485	1
117	USB Network Adapter 10/100 BaseTX RJ45	1
	<u>Power supply:</u>	
119	Adjustable 3-phase power supply, 0-450V/2A	1
120	Three-phase power supply with motor protection switch and a Regulating transformer, exciter 0-200 V	1
121	Multiple socket outlet, 5 fold	1
	<u>Measuring instruments:</u>	
122	Three Phase Power Quality Meter with display and long-term memory	2
	<u>Accessories:</u>	
123-126	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth	As required
127	Set of safety measurement cables, 4mm	1
	<u>Mobile Work Station</u>	
128	Mobile aluminum experiment stand, 3 levels with 6 earthed sockets or more	2
129	PC holder for experiment trolleys, height and width adjustable	2
130	Monitor holder for flat screen monitor	2
131	Keyboard and mouse platform for the experiment stand	2
132	Wall or aluminum-profile mounting cable storage	2
	<u>Power transmission</u>	
133	Transmission line Model 150km/300km (93.2miles/186.4miles) or greater	1
134	Capacitive load, three-phase, 1kW	1
135	Variable Ohmic load, three-phase, 1kW	1
136	Inductive load, three-phase, 1kW	1
137	Power switch module	1
138	Transmission line Model 150km/300km (93.2miles/186.4miles) or greater	1
139	Earth fault compensation unit	1
140	Exciter voltage controller with de-excitation	1
141	Synchronization Unit	1
142	Three-phase synchronous machine with smooth core rotor, 1kW	1
143	Servo machine test bench for 1kW machines with controlling software	1
144	Rubber coupling sleeve, 1kW	1
145	Coupling guard, 1kW	1
148	Cable Model 12,5 km / 37,5 km (7.8 miles / 23.3 miles) or greater	1
149	Conversion station 380 V/110 V	1

150	Cable Model 12,5 km / 37,5 km (7.8 miles / 23.3 miles) or greater	1
151	Conversion station 380 V/110 V	1
152	Three Phase Power Quality Meter with display and long-term memory	2
	<u>Protective systems for high-voltage transmission lines</u>	
153	Time Overcurrent Relay	1
154	Transmission line Model 150km/300km (93.2miles/186.4miles) or greater	1
155	Power switch module	2
156	Variable Ohmic load, three-phase, 1kW	1
157	Time Overcurrent Relay with directional feature	1
158	Time Over / Undervoltage Relay	1
159	Power and Reverse power relay	1
160	Earth fault voltage Relay	1
161	Voltage transformer, 3 phase	1
162	Time Overcurrent Relay	1
163	Time Overcurrent Relay with directional feature	2
164	Transmission line Model 150km/300km (93.2miles/186.4miles) or greater	1
165	Power switch module	1
166	High-speed distance protection relay	1
167	Voltage transformer, 3 phase	1
168	Current transformer, 3 phase	1
169	Transmission line Model 150km/300km (93.2miles/186.4miles) or greater	1
171	USB Network Adapter 10/100 BaseTX RJ45	1
173	Interface converter USB/RS485	1
	<u>Measuring instruments:</u>	
174	Three Phase Power Quality Meter with display and long-term memory	2
175	Power Multimeter	1
176	Relay Test Unit	1
	<u>Power supply:</u>	
177	Adjustable 3-phase power supply, 0-450V/2A	1
179	Multiple socket outlet, 5 fold	2
	<u>Accessories:</u>	
180-183	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth	As required
184	Set of safety measurement cables, 4mm	1
185	Connection plugs for PROFIBUS with PG socket and terminating resistor	5
186	Connection cable for PROFIBUS, per metre	10
187	Wire stripper for PROFIBUS cables	1
	<u>Mobile Work Station</u>	
188	Mobile aluminum experiment stand, 3 levels, power strip with 6 sockets with Protected power distribution for working stations, Keyboard and mouse platform	1
189	Wall or aluminum-profile mounting cable storage	1

190	PC holder for experiment trolleys, height and width adjustable	1
191	Monitor holder for flat screen monitor	1
	<u>Electric Power Distribution</u>	
192	Double busbar unit, three-phase, incoming / outgoing feeder	4
193	Double busbar unit, three-phase, coupler panel	1
194	Variable Ohmic load, three-phase, 1kW	1
195	Ohmic load 3x 560 Ohm	1
196	Three-phase asynchronous motor, squirrel-cage, 1kW	1
198	Transmission line Model 150km/300km (93.2miles/186.4miles) or greater	1
200	USB Network Adapter 10/100 BaseTX RJ45	1
202	Interface converter USB/RS485	1
203	Set of Balancing transformer	1
204	Time Overcurrent Relay	1
205	Power switch module	1
207	USB Network Adapter 10/100 BaseTX RJ45	1
209	Interface converter USB/RS485	1
	<u>Power supply:</u>	
210	Adjustable 3-phase power supply, 0-450V/2A	1
212	Multiple socket outlet, 5 fold	1
	<u>Measuring instruments:</u>	
213	Three Phase Power Quality Meter with display and long-term memory	1
	<u>Accessories:</u>	
214-217	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth	As required
218	Set of safety measurement cables, 4mm	1
219	Safety measurement cable (4mm) , 25cm, black	6
220	Connection plugs for PROFIBUS with PG socket and terminating resistor	5
221	Connection cable for PROFIBUS, per metre	10
222	Wire stripper for PROFIBUS cables	1
	<u>Mobile Work Station</u>	
223	Mobile aluminum experiment stand, 3 levels, power strip with 6 earthed sockets, Keyboard and mouse platform	2
224	Wall or aluminum-profile mounting cable storage	2
225	PC holder for experiment trolleys, height and width adjustable	2
226	Monitor holder for flat screen monitor	2
	<u>Energy management</u>	
227	Variable Ohmic load, three-phase, 1kW	1
228	Capacitive load, three-phase, 1kW	1
229	Inductive load, three-phase, 1kW	1
230	Three-phase asynchronous motor, squirrel-cage, 1kW along with a Motor protection switch, 3 pole	1
231	Star-Delta switch	1
232	Servo machine test bench for 1kW machines with controlling software	1
233	Rubber coupling sleeve, 1kW	1

234	Coupling guard, 1kW	1
237	Reactive Power controller	1
238	Switchable Capacitor Battery	1
	<u>Power supply:</u>	
239	Universal power supply for DC and Three-Phase Current	1
240	Adjustable 3-phase power supply, 0-450V/2A	1
	<u>Measuring instruments:</u>	
242	Three Phase Power Quality Meter with display and long-term memory and a Power Multimeter	1
244	USB Network Adapter 10/100 BaseTX RJ45	1
	<u>Accessories:</u>	
246	Power switch module	1
247-250	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth	As required
251	Set of safety measurement cables, 4mm	1
	<u>Mobile Work Station</u>	
252	Mobile aluminum experiment stand, 3 levels, power strip with 6 earthed sockets, Keyboard and mouse platform	1
253	Wall or aluminum-profile mounting cable storage	1
254	PC holder for experiment trolleys, height and width adjustable	1
255	Monitor holder for flat screen monitor	1
	<u>"Smart Grid" - Intelligent power mains</u>	
	<u>Media:</u>	
256	Smart Grid Training software	1
	<u>Software:</u>	
257	software Scada viewer	1
258	Software SCADA for PowerLab, designer software	1
259	Training Software for Protection for bus bar systems	1
	Training Software for Generator protection	1
	Training Software for Protection for transformers	1
	Training Software for Protective systems for high-voltage transmission line	1
	<u>Accessories:</u>	
261	USB Network Adapter 10/100 BaseTX RJ45	3
263-266	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth	As required
267	Set of safety measurement cables, 4mm	2
268	Safety measurement cable (4mm) 25cm, black	6
269	Interface converter USB/RS485	1
270	Connection plugs for PROFIBUS with PG socket and terminating resistor	10
271	Connection cable for PROFIBUS, per metre	20
272	Wire stripper for PROFIBUS cables	1
	<u>Laboratory Facilities</u>	
	<u>Instructor Workstation</u>	
273	table with sliding top, approx 6ft wide X 3 ft deep	1
274	PC holder for table	1
275	Under the table cabinet with wheels having minimum three	1

	drawers, a utensil drawer with central locking	
279	Multiple socket outlet, 6 fold, with illuminated switch	1
	Work Station for the Trainee	
280	table with sliding top, approximately 6ft wide x 3 feet with two (2) special Lab rotating chair with molded texture, varnished in natural colors, continuous height adjustment by means of a gas lift mechanism with top release, non-tipping aluminum base with epoxy-resin coating	8
281	PC holder for table	8
286	Multiple socket outlet, 6 fold, with illuminated switch	10
	Storage Facilities	
288	Open shelf cabinet to accommodate PC Interface courses	2
289	Storage cabinet with 2 hinged door approximately 3ft wide, 2 ft deep and 6 ½ feet height	2
290	Appropriately sized Shelf for the storage cabinet at item 289 with grooved mat on underside	2
291	Appropriately sized Shelf for the storage cabinet at item 289 with grooved mat on both sides	6
292	Appropriately sized Shelf for the storage cabinet at item 289 with grooved mat on upper side	2
293	Storage cabinet with 2 hinged door approximately 3ft wide, 2 ft deep and 6 ½ feet height with glass window	4
294	Appropriately sized Shelf for the storage cabinet at item 293	20

POWER ENGINEERING AND ALTERNATIVE ENERGY LABORATORY
PART-2 (Lot Wise Only- Local Purchase):

S.No	Equipment Name and Specification	Qty
29, 108, 116, 170, 199, 206,243, 260,	Patch cable Cat5E 1x 1m yellow, 2x 2m yellow	8
31, 110, 118, 172,201, 208, 245, 262	5-Port Ethernet Switch	8
278	Padded swivel chair with armrests, continuous height adjustment via gas lift	1
287	Standard PC latest gen core i3, 8 GB DDR4 RAM 256 GB SSD with 22" TFT screen, optical mouse, WLAN Card, latest Windows original	8
295	Multimedia projector with CONNECTIVITY of HDMI, USB, LAN, Wi-Fi, Brightness greater than 3,800 Lumens with suitable sized electric screen with remote	1

4. ELECTRIC MACHINES, POWER ELECTRONICS & DRIVES LABORATORY (Lot Wise Only – Import Purchase):

Imported items must be; of advanced technological countries i.e. UK, USA, Japan and Western European Countries

S.No	Equipment Name and Specification	Qty
	Industrial Applications: DC Machine & Drives	
	DC machines	
1	DC multi-circuit, compound wound machine, 0.3kW	4
2	Universal rheostat for 300W machines	4
	<u>Media:</u>	
3	DC machines 0.3 kW Training software	1
4	Line commutated converter circuits	
5	Line-commutated power converters circuits	4
6	Three-phase isolating transformer 300VA	4
7	Power electronics load set, 300 W	4
	<u>Media:</u>	
8	Line-commutated power converter circuits Training software	1
9	Converter drives with DC motors	
11	Exciter for 0-200V regulating transformer	4
12	Tachogenerator 1V/1000 r.p.m., 0.3kW	4
13	Coupling guard, 0.3kW	4
14	Rubber coupling sleeve, 0.3kW	4
	<u>Machine test bench equipment set for servo-drive/braking system:</u>	
15	Servo machine test stand for 0.3kW machines with controlling software	4
16	Rubber coupling sleeve, 0.3kW	4
17	Coupling guard, 0.3kW	4
	<u>Power supply:</u>	
19	Universal power supply for electrical machines	4
	<u>Measuring instruments:</u>	
20	Power Multimeter	4
	<u>Accessories:</u>	
21	Set of safety measurement cables, 4mm	4
22 -25	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth	As required
	Mobile Work Station	
26	Mobile aluminum experiment stand, 3 levels and power strip with 6 earthed sockets	4
27	Wall or aluminum-profile mounting cable storage	4
28	PC holder for experiment trolleys, height/width adjustable	4
29	Keyboard and mouse platform for the experiment stand	4
30	Monitor holder for flat screen monitor	4
	Industrial Applications: AC Machines	
31	Universal motor, 0.3kW	4
32	Cut-out switch, 4 pole	4
33	AC-motor with bifilar winding, 0.3kW	4
34	AC-motor with starting & operating capacitor, 0.3kW	4
	Self-commutated converter circuits	
35	Self-commutated converter circuits	4
36	Three-phase isolating transformer 300VA	4

37	Power electronics load set, 300 W	4
	Frequency converter drives with three-phase asynchronous motor	
38	Three-phase asynchronous motor, 0.3kW n=1400 (230V/400V)	4
40	Tachogenerator 1V/1000 r.p.m., 0.3kW	4
41	Coupling guard, 0.1/0.3kW, transparent	4
42	Rubber coupling sleeve, 0.3kW	4
	Field-oriented control of asynchronous machine with Matlab - Simulink 300W	
43	USB adapter with Matlab toolbox for power electronics	4
44	Incremental position encoder 1024 pulses	4
	<u>Media:</u>	
45	Field-oriented control using Matlab-Simulink training software	1
	Regulated permanent magnet servo drive with Matlab - Simulink 300W	
46	Permanent Magnet Synchronous Motor (PMSM) 0.3 kW	4
47	Servo drives using Matlab-Simulink training software	1
49	Regulating transformer, exciter 0-200 V with Exciter power supply for electrical machines	4
	<u>Machine test bench equipment set for servo-drive/braking system:</u>	
50	Servo machine test stand for 0.3kW machines incl. software	4
51	Rubber coupling sleeve, 0.3kW	4
52	Coupling guard, 0.3kW, transparent	4
	<u>Power supply:</u>	
54	Universal power supply for electrical machines	4
	<u>Measuring instruments:</u>	
55	Power Multimeter	4
	<u>Accessories:</u>	
56	Set of safety measurement cables, 4mm (31 leads or more)	4
57-60	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth 1000V/32A	As required
	Mobile Work Station	
61	Mobile aluminum experiment stand, 3 levels and power strip with 6 earthed sockets or more	4
62	Wall or aluminum-profile mounting cable storage	4
63	PC holder for experiment trolleys, height/width adjustable	4
64	Keyboard and mouse platform for the aluminum profile system	4
65	Monitor holder for flat screen monitor	4
	Industrial Application: Smooth Start and Frequency Converters	
66	Smooth starter industrial type for 3-phase asynchronous machines up to 1kW	1
67	Three-phase asynchronous motor, 0.3kW n=1400 (230V/400V)	1
	<u>Media:</u>	
68	Industrial smooth starter, freq. converter 0.3 kW training software	1
69	Frequency converter drives	
70	Frequency converter 0.75kW (Lenze 8400 or equivalent)	1

71	Brake resistor 0.2kW for frequency converters	1
	<u>Machine test bench equipment set for servo-drive/braking system:</u>	
75	Servo machine test stand for 0.3kW machines with controlling software	1
76	Rubber coupling sleeve, 0.3kW	1
77	Coupling guard, 0.3kW	1
	<u>Power supply:</u>	
79	Three-phase power supply with motor protection switch with Power-Multimeter	1
	<u>Accessories:</u>	
80	Set of safety measurement cables 4mm	1
81-82	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth 1000V/32A	As required
	Mobile Work Station	
83	Mobile aluminium experiment stand, 3 levels and power strip with 6 earthed sockets or more	1
84	Wall or aluminium-profile mounting cable storage	1
85	PC holder for experiment trolleys, height/width adjustable	1
86	Keyboard and mouse platform for the aluminum profile system	1
87	Monitor holder for flat screen monitor	1
	Industrial Application: Positioning and Motor Management Positioning with servo drives/braking system	
88	Synchronous servo with motor, resolver & software	1
89	Linear unit 800/12	1
	<u>Media:</u>	
90	Manual/Software, Synchronous servo system	1
	Positioning with linear axis	
	<u>Software:</u>	
91	Positioning Software for servo machine test stand	1
	<u>Media:</u>	
92	Manual/Software, Positioning	1
93	Motor management relays	
94	Motor management relay with parameter setting software	1
95	Three-phase asynchronous motor, squirrel-cage, 0.3 kW	1
	<u>Media:</u>	
96	Manual/Software, Controlling motors with motor management relays	1
	<u>Machine test bench equipment set for servo-drive/braking system:</u>	
98	Servo machine test stand for 0.3kW machines with controlling software	1
99	Rubber coupling sleeve, 0.3kW	1
100	Coupling guard, 0.3kW	1
	<u>Power supply:</u>	
102	Three-phase power supply with motor protection switch	1
	<u>Measuring instruments:</u>	
103	Power Multimeter	1
	<u>Accessories:</u>	

104	Set of safety measurement cables 4mm	1
105-106	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth 1000V/32A	As required
	Mobile Work Station	
107	Mobile aluminium experiment stand, 3 levels and power strip with 6 earthed sockets or more	1
108	Wall or aluminum-profile mounting cable storage	1
109	PC holder for experiment trolleys, height/width adjustable	1
110	Keyboard and mouse platform for the aluminum profile system	1
111	Monitor holder for flat screen monitor	1
	Fault simulation on electrical machines	
112	Fault simulator for three-phase asynchronous squirrel-cage motor	1
113	Three-phase asynchronous motor, squirrel-cage, 0.3 kW	1
114	Insulation tester with insulation resistance range from 10 k ohm to 999 M ohm	1
	Media:	
115	Manual/Software, Troubleshooting on electrical machines	1
	Protection for electrical machines	
116	Board for motor protection systems 300W	1
117	Three-phase induction motor with various temperature sensors, 0.3kW	1
118	True RMS digital multimeter with measurements up to 100 kHz and datalogger function	1
	Media:	
119	Manual/Software, Protection for electrical machines	1
	Machine test bench equipment set for servo-drive/braking system:	
120	Servo machine test stand for 0.3kW machines with controlling software	1
121	Rubber coupling sleeve, 0.3kW	1
122	Coupling guard, 0.3kW	1
	Power supply:	
124	Three-phase power supply with motor protection switch	1
	Measuring instruments:	
125	Power Multimeter	1
	Accessories:	
126	Set of safety measurement cables 4mm	1
127-128	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth 1000V/32A	As required
	Mobile Work Station	
129	Mobile aluminum experiment stand, 3 levels and power strip with 6 sockets or more	1
130	Wall or aluminum-profile mounting cable storage	1
131	PC holder for experiment trolleys, height/width adjustable	1
132	Keyboard and mouse platform for the aluminum profile system	1
133	Monitor holder for flat screen monitor	1
	Industrial Application: Transformers	
134	Transformer trainer	4
135	RLC load	4

	<u>Media:</u>	
136	Manual/Software, Single-phase and three-phase transformers	4
	<u>Measuring instruments:</u>	
137	Lab multimeter with IR interface. 3 ½ digit multimeter resolution: ±3000 digits Voltage measuring ranges: 30 mV-1000 V DC, 3 V-1000 V AC; current measuring ranges: 3 mA-16 A DC; 30 mA-10 A AC Resistance ranges: 30Ω to 30 MΩ Bar Chart Display Backlighting with a Power MultiMeter	4
	<u>Accessories:</u>	
138	Set of safety measurement cables 4mm	4
139-140	Safety connection plug 19mm/4mm with tapping in three colors for live, neutral and earth 1000V/32A	As required
	Mobile Work Station	
141	Mobile aluminum experiment stand, 3 levels and power strip with 6 earthed sockets or more	4
142	Wall or aluminum-profile mounting cable storage	4
143	PC holder for experiment trolleys, height/width adjustable	4
144	Keyboard and mouse platform for the aluminum profile system	4
145	Monitor holder for flat screen monitor	4
146	Stepper motors Training Card for the PC Interfaced hardware	4
147	Brushless DC/servo motors Training Card for the PC Interfaced hardware	4
148	PC Interfaced hardware with virtual instruments (Voltmeter, Ammeter, Multi meter, 2 channel oscilloscope, Function generator etc.)	4
149	PC Interface Experiment work Area to accommodate training cards and/or breadboards for experimenting	4
150	PC Interfaced hardware measurement accessories, shunts and connection cables	4
151	Lab multimeter 4 ½ digit multimeter; resolution: ±30,000 digits Voltage measuring ranges: 300 mV-1000 V current measuring ranges: 300 μA-10 A Resistance ranges: 300Ω to 30 MΩ Capacitance range: 3 nF to 10,000 μF Continuity and diode testing Frequency range up-to 100k Hz	4
153	table with sliding top, approximately 6ft wide x 3ft deep with three (3) special Lab rotating chair with molded texture, varnished in natural colors, continuous height adjustment by means of a gas lift mechanism with top release, non-tipping aluminum base with epoxy-resin coating	5
154	PC holder for table	5
155	Under the table cabinet with minimum 3 drawers, a utensil drawer with central locking	1
159	Multiple socket outlet, 6 fold, with illuminated switch	5
	Storage Facilities	

161	Open shelf cabinet to accommodate PC Interfaced courses	1
162	Storage cabinet with 2 hinged door approximately 3ft wide, 2 ft deep and 6 ½ feet height	2
163	Appropriately sized Shelf for the storage cabinet at item 162 with grooved mat on underside	2
164	Appropriately sized Shelf for the storage cabinet at item 162 with grooved mat on both sides	6
165	Appropriately sized Shelf for the storage cabinet at item 162 with grooved mat on upper side	2
166	Storage cabinet with 2 hinged door approximately 3ft wide, 2 ft deep and 6 ½ feet height	2
167	Appropriately sized Shelf for the storage cabinet at item 166	10

5. MEASUREMENT LAB EQUIPMENT PART-1 (Lot Wise Only – Import Purchase):

Imported items must be; of advanced technological countries i.e. UK, USA, Japan and Western European Countries

S.No	Equipment Name and Specification	Qty
17	PC Interfaced hardware with virtual instruments (Voltmeter, Ammeter, Multi meter, 2 channel oscilloscope, Function generator etc.)	8
18	PC Interface Experiment work Area to accommodate training cards and/or breadboards for experimenting	8
19	PC Interfaced hardware measurement accessories, shunts and connection cables	8
	Measurement of Non-Electric Values	
25	Temperature, Pressure, Force & Torque measurement training card for the PC Interfaced hardware	8
26	Displacement, Angle and Speed measurement training card for the PC Interfaced hardware	8
	Measurement of Electric Values	
27	Current, Voltage, Power, Phase & Frequency measurement training card for the PC Interfaced hardware	8
28	Inductance, Capacitance, and Resistance measurement training card for the PC Interfaced hardware	8
32	Lab multimeter with IR interface. 3 ½ digit multimeter resolution: ±3000 digits Voltage measuring ranges: 30 mV-1000 V DC, 3 V-1000 V AC; current measuring ranges: 3 mA-16 A DC; 30 mA-10 A AC Resistance ranges: 30Ω to 30 MΩ Bar Chart Display Backlighting	8
33	Digital dual trace storage oscilloscope w. colour display, incl. probes 30MHz or greater	8
	Servo Technology	
32	DC Servo motor for Digital Position and Speed Control training board for the PC Interfaced hardware	8
	Instructor Workstation	

33	table with sliding top, approximately 6ft wide x 3ft deep	1
34	PC holder for table	1
35	Under the table cabinet on wheels with minimum three drawers, utensil drawer with central locking	1
	Work Station for the Trainee	
40	table with sliding top, approximately 6 ft wide x 3 ft deep with two (2) special Lab rotating chair with molded texture, varnished in natural colors, continuous height adjustment by means of a gas lift mechanism with top release, non-tipping aluminum base with epoxy-resin coating	8
41	PC holder for table	8
	Storage Facilities	
48	Open shelf cabinet to accommodate PC Interface courses	2
49	Storage cabinet with 2 hinged door approximately 3ft wide, 2 ft deep and 6 ½ feet height	2
50	Appropriately sized Shelf for the storage cabinet at item 49	8

MEASUREMENT LAB EQUIPMENT PART-2 (Lot Wise Only – Local Purchase):

S.No	Equipment Name and Specification	Qty
38	Cushioned swivel chair with armrests, adjustable to any height by means of gas lift pillar	1
39	Multiple socket outlet, 6 fold, with illuminated switch	1
46	Multiple socket outlet, 6 fold, with illuminated switch	8
	LAN and PC's	
47	Standard PC latest gen core i3, 8 GB DDR4 RAM 256 GB SSD with 22" TFT screen, optical mouse, WLAN Card, latest Windows original	8
	Chalk board / white board / projector screen	
51	Multimedia projector with connectivity of HDMI, USB, LAN, Wi-Fi, brightness greater than 3,800 Lumens with suitable sized electric screen with remote	1

6. CENTRAL ELECTRICAL WORKSHOP PART 1 (LOT-WISE ONLY – IMPORT PURCHASE):

Imported items must be; of advanced technological countries i.e. UK, USA, Japan and Western European Countries

S No.	Item Description	Qty
1	Training system to teach the fundamentals of AC/DC and Three-Phase Electrical Systems	4
2	Training system to teach testing of protective systems in buildings in accordance with standards and regulations	4
3	Tester for equipment conforming to DIN VDE IN VDE 0701-0702,	4
4	Testing adapter set for various VDE tests	4
5	Installation tester for testing protective circuitry according to DIN VDE 0100, RCD type B	4
6	Lab multimeter with IR interface. 3 ½ digit multimeter resolution: ±3000 digits Voltage measuring ranges: 30 mV-1000 V DC, 3 V-1000 V AC; current measuring ranges: 3 mA-16 A DC; 30 mA-10 A AC Resistance ranges: 30Ω to 30 MΩ Bar Chart Display Backlighting	4
	Residential & Industrial wiring planning & installation training systems	
7	Building service entry trainer teaching interface, house connection, distribution all with fault simulation	2
8	Wiring installation for lighting and appliance circuits training system teaching interface, lighting & appliance wiring all with fault simulation	2
9	Set of safety measurement cables, 4mm having appropriate number of leads for experiments	2
10	Industrial electricity distribution training system teaching interface for industrial distribution system all with fault simulation	2
11	Voltage, phase + continuity tester with field direction indicator, max. 690V	2
12	Mobile stand for Building service entry trainer , Wiring installation for lighting and appliance circuits training system and Residential & Industrial wiring planning & installation training system	6
13	Mobile stand mounting storage for 4mm cables	6
	Equipment for practical exercises in wiring installation	
	Building installation	
14	Installation materials Set 1: 1 Automatic fuse, A 1 On-off switch with indicator light 2 Change-over switches 1 Multiple switch 1 Cross-over switch 3 Push-buttons 2 Sockets with earth contacts 2 PVC connectors for switches 3 Junction boxes 3 Oval lamps, LED	4

	1 Remote current pulse switch 1S9; 230 V 1 Stairway light controller 10 Screw connections PG 16 13 Blank plugs PG 16 3x 3m long ISO-S pipe PG11 3 ISO-S bends PG11 with clamp	
15	Set of installation materials Set 2: 2 Fluorescent lamp sockets 2 Fluorescent lamp sockets with starter sockets 2 Starters 2 Fluorescent lamps, 20 W 2 Ballasts, 20 W 1 Ballast, 40 W 1 Capacitor, 2.7 μ F with fastening clip	4
16	Wiring fastening set: 20 ISO clips 6-16, single-fold 7 ISO clips 6-16, 2-fold	4
17	clamping materials for leads and cables: 15 Sets of screw terminals 30 Clamp terminals, 5-pole 1.5 mm ² 1 Roll of Coroplast	4
19	Exercise Manual for Assembly practice on wiring installation and fluorescent light circuits	1
	Door bell and intercom systems	
20	Set of materials for assembly of doorbell circuit 3 Junction boxes 6 Doorbell buttons 1 Door opener, 4 - 8 V 2 Acoustic signal units with a flat shell, 5 - 8 V 1 Bell transformer, 3-5-8 V/2 A 11 Screw connections, PG16 10 Blank plugs PG16 5 ISO-S pipes, 365mm long, PG11 2 ISO-S pipes, 200mm long, PG11 3 ISO-S bends PG11 with sleeve	4
22	Set of materials for intercom 1 Entrance intercom station 2 Building intercom stations 1 Power supply unit	4
23	Exercise Manual for Wiring practice with door bell and intercom systems	1
	Building mains feeds and meter cabinets	
24	Meter cabinet set: Meter cabinet Mains feed panel with bus bars Meter panel 6-row distribution panel Selective line circuit breakers, 3-pole Three-phase meter, 40 A RCD, 30mA, 3-pole B16 line circuit breaker, 3-pole 2 x B16 line circuit breakers, 1-pole Phase rail Main supply line junction terminals Small components for meter cabinet	4

	Set of labels	
25	Set of installation circuits: 1 Cross-over switch 2 Two-way switches 1 Touch switch 1 Remote switch 1 Mains socket 1 CEE socket 1 Lighting strip with fluorescent tube 1 Storage case for wiring material	4
26	clamping materials for leads and cables: 15 Sets of screw terminals 30 Clamp terminals, 5-pole 1.5 mm ² 1 Roll of Coroplast	4
28	Wiring fastening set: 20 ISO clips 6-16, single-fold 7 ISO clips 6-16, 2-fold	4
29	Exercise Manual for Planning and installation of building mains feed	1
	Switching units	
30	Set of materials: 3 Main contactors 230 V 2 Time-delay relays, delayed response 2 Push-buttons 1 Overcurrent relays 1 Red indicator lamp 1 Green indicator lamp 1 Switch	4
31	Terminal strip set1 for for wiring control circuits: 15 Terminal strips, grey 5 Terminal strips, blue 5 Terminal strips, green/yellow 1 Bridge terminal 2 End terminals Strip labelling band	4
32	Terminal strip set2 for for wiring control circuits: 6 Terminal strips, grey 1 Terminal strip, green/yellow 1 Bridge terminal 2 End terminals Strip labelling band 7 Test plugs 7 Adapter plugs	4
33	Set of NEOZED fuses for circuits protection: 4 Fuse sockets 3 Fuses, 10 A 1 Fuse, 2 A	4
34	Cable duct (channel) wiring support unit	4
35	Wiring fastening set: 20 ISO clips 6-16, single-fold 7 ISO clips 6-16, 2-fold	4
37	Exercise Manual for Practice on Switchgear Circuits	1
	Measuring Instruments	

38	Voltage, phase + continuity tester with field direction indicator, max. 690V	4
39	TRMS digital multimeter	4
	Accessories	
40	Storage tray for SE boxes, reinforced, (10 boxes)	1
41	Storage tray for installation materials, reinforced base	8
42	Set of plastic dowels for punched hole frame	4
43	Set of screws for punched hole frame 50 screws, 3.5 x 13 mm 20 screws, 3.5 x 25 mm 30 screws, 2.9 x 19 mm	4
44	Safety measurement cable 4mm, 100 cm, black, 600 V CAT III ~ 1000 V, CAT II / 32 A	20
45	Safety measurement cable 4mm, 100cm/40", blue, 600V CAT III ~1000V CAT II / 32A	4
46	Safety measurement cable 4mm, 100cm/40", gr/ye, 600V CAT III ~1000V CAT II / 32A	4
47	Lab table for punched hole frame approximately 5ft wide, 2 ½ feet deep	4
48	Table-top punched hole frame for table at item # 47	4
49	Desktop Power duct for lab table with appropriate number of blank panels to complete cover the power duct unit	4
50	Full-width front plate for six-sided power supply duct	4
51	Mains connection box, 3x400V, three-phase	4
52	Lab table with sliding top uncovering a large cable duct capable of accommodating socket strips, small power supplies, IT and electricity supply systems, approximate dimensions 6ft wide x 3ft deep with PC holder	5
53	Instructor under the table cabinet on wheels with minimum three drawers, a utensil drawer and central locking	1
54	Storage cabinet with 2 hinged door approximately 3ft wide, 2 ft deep and 6 ½ feet height with glass window	4
55	Appropriately sized Shelf for the storage cabinet at item 54	16
56	Special Lab rotating chair with moulded texture, varnished in natural colors, continuous height adjustment by means of a gas lift mechanism with top release, non-tipping aluminum base with epoxy-resin coating	20

CENTRAL ELECTRICAL WORKSHOP PART 2 (Lot Wise Only – Import Purchase):**Imported items must be; of advanced technological countries i.e. UK, USA, Japan and Western European Countries**

S.No	Equipment Name and Specification	Qty
57	<p>PCB prototyping machine + software some important features include: Track width and spaces of 50um/ 30um is achieved with UV Repeatability (precision) <1 u m, Auto tool change, drilling capacity 120strokes/min, System for through-hole plating with conductive paste Consisting of:-</p> <ul style="list-style-type: none">- 20 Protection film foil- 2 Pressing Metal Sheet (210 x 160 mm)- 10 Filter fleece- 20 Paste packs of 2.5 grams (Shelf life: 6 months at 5°C)- 5 Base material FR4 18/18 um- 5 Base material FR4 35/35 u- 1 screen printing rakel, 1 brush, 1 pinch roller, 1 PCB cleaner- 1 Glove with inner lining- Desktop Vacuum Table- Hot Air Oven, Exhaust Unit, Hand Microscope, Digital slide gauge <p>Easy to use Rivets based through hole plating system Comes with required tools and 1000 each rivets of</p> <ul style="list-style-type: none">- 0.6 mm inner dia, 0.8 mm outer dia.- 0.8 mm inner dia, 1.0 mm outer dia.- 1.0 mm inner dia, 1.4 mm outer dia.- 1.2 mm inner dia, 1.6 mm outer dia. <p>Tool Tip A & B, Punching tool, Anvil & Assembly tweezers Base Plate FR4, 229 x 305 mm (9" x 12") 35/35um copper Base Plate FR4, 229 x 305 mm (9" x 12") 35/35um copper Laminate thickness: 1.55 mm. Pack of 10 pieces pack Base Plate FR4, 229 x 305 mm (9" x 12") 18/18um copper Laminate thickness: 1.55 mm. Pack of 10 pieces pack Universal Cutter 1/8", 36 mm, 0.2 – 0.5mm (8 – 20 mil) with distance ring Micro Cutter 1/8", 36 mm, 0.1 – 0.15mm (4 – 6 mil) 10 On 18 um copper with distance ring Set of End Mills 4 Consists of one pack each of End Mills with d = 0.8mm, 1.0 mm, Packs 2.0mm & 3.0mm (each pack consists of 10 pcs) Set of Contour Routers 2 Set of Drill Bits Compressor for D104 (#10058366) including Air Dryer & filter Max Pressure 10 bars, output 240 L/Min. 60 L container, Noise level 85 dB (A). 230 Volts 50 Hz.</p>	1

CENTRAL ELECTRICAL WORKSHOP PART 3 (Lot Wise Only – Local Purchase):

S.No	Equipment Name and Specification	Qty
18, 27	Electric Cables: 150 m cable, 3x 1.5 mm ² (with green/yellow core) 300/500V 50 m cable, 3x 1.5 mm ² (without green/yellow core) 300/500V 150 m cable, 5x 1.5 mm ² (with green/yellow core) 300/500V 200 m wire, 1.5 mm ² , black, PVC, 450/750V 100 m wire, 1.5 mm ² , blue, PVC, 450/750V 100 m wire, 1.5 mm ² , yellow/green, PVC, 450/750V 200 m wire, 1.5 mm ² , brown, PVC, 450/750V British or IEC standards	2
21	Set of wires: 100m wire, 0.8 mm ² , black, PVC Insulated Telecom Wire 100m wire, 0.8 mm ² , white, PVC Insulated Telecom Wire 100m wire, 0.8 mm ² , blue, PVC Insulated Telecom Wire 100m wire, 0.8 mm ² , brown, PVC Insulated Telecom Wire	1
36	Electric Cables: 400 m cable, 1 x 1.5 mm ² , black PVC 100 m cable, 7 x 1.5 mm ² , black PVC 100 m cable, 3 X 1.5 mm ² , black, PVC 100 m cable, 4 X 1.5 mm ² , black, PVC 100 m cable, 5 X 1.5 mm ² , black, PVC 1000 wire sleeves 1.5mm ² , Copper Alloy, Tin Finish, Wire Terminal British or IEC standards	1
58	Instructor cushioned comfort swivel chair with armrests, allowing for multiple adjustment to any height for the lab instructor	1
59	Standard PC latest gen core i3, 8 GB DDR4 RAM 256 GB SSD with 22" TFT screen, optical mouse, WLAN Card, latest Windows original	9
60	4000 or more, lumens 1080p or more, ultra-short throw projector	1
61	Whiteboard, minimum 2000 x 1200 mm, cleaned off with dry cloth	1
62	High Quality 6 sockets extension board with on/off switch	13
63	High Quality Electrician Tools Set, must include: 1 Pcs 4.5" Long nose pliers 1 Pcs 4.5" Diagonal cutting pliers 1 Pcs 7.5" Wire stripper 1 Pcs Slotted screwdriver SL5.5x 100mm 1 Pcs Phillips screwdriver PH1x 100mm 1 Pcs Snap-off blade knife 1 Pcs Test pencil 140mm 1 Pcs PVC Insulating tape 1 Pcs Tweezers 125mm 1 Pcs 5.5" Electrician's Scissors 1 Pcs Tools bag	12

7. COMPUTER LAB & ALLIED FACILITIES (Lot Wise Only – Local Purchase)

S. No	Particulars	Qty
1	Branded PCs for two Computer Lab, latest gen core i7, 16 GB DDR4 RAM 512 GB SSD with 24" TFT screen, optical mouse, WLAN Card, latest Windows original	80
2	All in one Printer HP preferred 30 ppm or faster	1
3	Heavy duty Photocopier HP, Canon , Toshiba	2
4	Network Business Printer HP preferred Print speed letter: Up to 40 ppm (black) Prints up to 11x 17"; Auto duplex printing; 3 paper trays (standard)	2
5	LCD 80" or greater	2

Civil Engineering Department

1) HYDRAULIC LAB, CIVIL ENGINEERING DEPARTMENT (Lot Wise Only – Import Purchase)

Imported items must be; of advanced technological countries i.e. UK, USA, Japan and Western European Countries

S. No.	Description	Qty
01	<p>Hydraulic Bench</p> <p>Specifications: Electronic Flow meter with digital display for accurate measurements. Flow range: 0.001 L.s⁻¹ and 0.1 L.min⁻¹ resolution, Sump tank maximum capacity: 160 – 250 liters, Maximum flow: 55 – 60 litres/minute, Maximum pressure: 450 mbar at working surface height, A hand operated Control Valve adjusts the water flow rate, An electrical box to contain the pump switch, circuit protection and a digital display of flow, A sight gauge allows the user to check the water level, Electric Submersible Pump, Motor power: 200 watts, include Water Additive and all necessary pipes and pipe clips</p>	2
02	<p>Pelton Wheel Turbine</p> <p>Specifications: To consist of a Pelton turbine mounted vertically in a tubular housing approximately 180 mm OD with 9 mm wall, with anodised and painted aluminium end plates and clear PETG windows each end, a drum connected to the runner, with a cord and two spring-balances for loading the turbine, and taking torque measurements, Drum Radius 25 mm, Effective Turbine Radius 46 mm, 16x split buckets, mounted in an anodised aluminium runner, held in a stainless steel shaft running in stainless steel bearings. Bearing housing solid anodised aluminium, Brake mechanism with two spring balances rated at 30 N in 0.5 N increments, nylon brake band, hollow steel brake drum with 50 mm diameter, Spear valve travel is 1.5 mm per turn, maximum travel nominally 6.75 mm (4½ turns), Maximum turbine (no load) speed: 1000 – 3800 rev.min⁻¹ Maximum brake power: typically, 3.5 W at 500 rev.min⁻¹</p> <p>Optical Tachometer A compact hand-held optical tachometer with a 5-digit high-brightness LED display and a speed range 3 to 99999 RPM.</p>	2
03	<p>GLASS SIDED TILTING FLUME</p> <p>Includes: Control Box and Instrument Frame with Data Acquisition System, Float Switch, Sluice Gate, Level Gauges, Pitot Tube, Sharp Crested Weir, Powered End Gate, Digital Instrument Carrier, 32-Way Pressure Display Weirs: Broad Crested Weirs (Sharp and Streamlined), Rectangular, V-</p>	1

S. No.	Description	Qty
	<p>Notch, Cipolletti, Sutro. Dam Spillway Model</p> <p>Specification: Cross section: 300mm (0.30 m) Wide and 450mm (0.45 m) Depth. Construction: The channel is constructed using 2.5m long sections, Nominal channel length: 5 Metre, Material: 10mm toughened glass, Finish: Polished edges</p> <p>Channel Bed: Material: Stainless steel type 316L, Construction: Laser fusion welded, fixing points at 0.5m intervals, Pressure Tappings at 0.25m intervals. Can be connected with a 32-way digital pressure display is DAQ compatible, allowing real-time data acquisition. Mounted on a rigid box section spine.</p> <p>Pump: Horizontal centrifugal close couple bronze pump, Capacity: 130 m³/h at 4.5m, Inclination: Driven by twin cubic screw jacks, 5 metre flumes: Inclination by a minimum of +2.5% to -0.5%, Limit switches ensure safe operation and define the range of inclination. Volume Flow Rate Measurement Device. Display of Flow Rate and Flume Inclination: Device mounted on the flume, Backlit LCD displays flow rate as measured by the Flow Rate Measurement Device. Volume flow rate displayed to in Ls⁻¹with 2 decimal places. Channel Inclination displayed in % with 2 decimal places. Tare button allows reset of the inclination zero angle. Digital DAQ socket allows flow and inclination to be output to data acquisition system.</p> <p>Storage Tanks: Water tank storage capacity: 2400 Litres, Flow Rate: Maximum: 2100 l.min⁻¹</p>	
4	<p>Water Current Meter Price Type AA with Analog & Digital Outfits</p> <p>Price Type Current Meters Price type Current Meter outfit with 2m wading rod set, 15m hand suspension cable, 6.8 Kg sounding weight, headphone set and canvas equipment bag, Digital Indicator, Analog to Digital Adapter</p> <p>Specifications Accuracy: 2% Minimum Depth Required Cable suspended: 18 inches Rod suspended: 6 inches Dimensions Bucket open end diameter: 2.0 inches Bucket wheel diameter: 5 inches Operating Range Feet per second: 0.2 - 25 Meters per second: 0.06 - 7.6</p>	1
5	<p>Water Current Meter Pygmy Type with Analog & Digital Outfits</p> <p>Rod Suspended Pygmy Meter Outfit with Headphones, Metric, Digital Indicator, Analog to Digital Adapter</p> <p>Specifications</p>	1

S. No.	Description	Qty
	Accuracy: 2% Minimum Depth Required Cable suspended: Not Applicable Rod suspended: 3 inches Dimensions Bucket open end diameter: 0.78 inches Bucket wheel diameter: 2 inches Operating Range Feet per second: 0.05 - 3.0* (0.02 - 15.00) Meters per second: 0.02 - 0.9* (0.02 - 4.57)	
6	<p>Current Meter Propeller Type</p> <p>The measurements are executed with the propeller mounted on the rod(s) or connected to a cable. The current velocity meter has a measuring range of 0.025 to 10 m/sec. The meter with the extension rods is usually applied for measurements in shallow creeks or rivers with low current velocities. The digital counter, fitted with a carrier belt, registers up to 10 pulses per seconds. In large water ways with higher water levels and current velocities the current velocity meter can be connected to a cable with single drum winch (optional), which can be mounted either to the railing of a bridge or a boat.</p> <p>Complete set includes: Streamlined current velocity meter with a synthetic propeller, Digital counter, Extension rods with graduation, Cable, Case, Accessories</p> <p>Specifications Current meter with synthetic propeller Measured parameters: Meter per second Measuring range: 0.025 - 10 m/s Production material: Stainless steel Standard propeller diameter: 125 mm Rod length: 2 m Registration type: Manual or logging Package size 114 x 47 x 56 cm Weight 7.5 kg</p>	1
7	<p>Hydrostatics Bench and Properties of Fluids</p> <p>Self-contained mobile unit for experiments in fluid mechanics, properties of fluids, hydrostatic principles and buoyancy/floatation and Archimede's principle.</p> <p>Includes: • Reservoir tank with hand pump • Hook gauge • Fluid level apparatus: 5 off interconnected glass tubes of varying cross sections and shapes • Pressure gauge: Bourdon type with visible mechanism and dead weight calibrator • Manometers: 2 off U-tubes • Capillarity apparatus: glass tubes of various bores, glass plates with plastic shims for various separations • Calibrated hydrometer • Measuring cylinder • Graduated beaker • Timer • Floating rectangular pontoon with adjustable centre of gravity</p>	1

S. No.	Description	Qty
	<ul style="list-style-type: none"> • Specific gravity bottle • Eureka can • Air pump • Three-beam balance • Centre of pressure tank and balance • Archimedes' mass • Various ball bearings • 3 x 100 ml glass beakers • Two acrylic tubes mounted on a metal frame, connected in an 'm' formation to a syringe. Surface Tension Balance, Hares Tube, Half Circle and Vee Chine Pontoons. <p>Centre of pressure tank and balance: To consist of a clear Perspex quadrant Quadrant dimensions: Inner radius 100 mm, Outer radius 200 mm, Breadth 75 mm. Moment arm radius to be 200 mm, 2x 10 g Weight Hangers with 100x 10 g weights Bourdon Gauge with visible mechanism and dead weight calibrator, Pressure Gauge Calibration Cylinder with Piston Weight Platform and PVC Tube, Slotted Cast Iron Weights – 4 x 1 kg, 2 x 0.5 kg, 1 x 200 g, Fluid Manometer with SG 1.99 Manometer Fluid, Water Manometer, Cycle Pump, Hydrometer 0.7–2.0, Ball Guide</p>	
8	<p>Pipe Friction Apparatus</p> <p>Free-standing, mobile apparatus demonstrates pressure losses in several small-bore pipe circuit components, typical of those found in central heating systems.</p> <p>Specification</p> <ul style="list-style-type: none"> • Two colour coded circuits made of small-bore copper pipe, one painted dark blue, one painted light blue, mounted on a vertical board with castors <ul style="list-style-type: none"> ○ Dark blue circuit to contain: <ul style="list-style-type: none"> ▪ Straight pipe with 13.7mm bore ▪ 90° Sharp bend (mitre) ▪ Proprietary 90° elbow ▪ Gate valve. ○ Light blue circuit to contain: <ul style="list-style-type: none"> ▪ Sudden expansion – 13.6mm/26.2mm ▪ Sudden contraction – 26.2mm/13.6mm ▪ Smooth 90° bend with 50.8mm radius ▪ Smooth 90° bend with 100mm radius ▪ Smooth 90° bend with 152mm radius ▪ Globe valve • Straight pipe 26.4mm • 90-degree mitre bend (no radius) • Elbow (13.6 mm radius) • Small radius, smooth 90° bend (50 mm radius) • Medium radius, smooth 90° bend (100 mm radius) • Large radius, smooth 90° bend (150 mm radius) • Pressure loss across valves measured by pressure gauge • Pressure across all other component to be measured by 8 piezometer tubes • Distance L between pressure tapings = 0.914 m. • Hand pump to be supplied to adjust the datum position of the manometers. • Roughened Pipe: Internal coating thickness: 300 µm to 600 µm, Pipe diameter: 18 mm 	1

S. No.	Description	Qty
9	<p>Osborne Reynolds Apparatus</p> <p>Free-standing apparatus that gives a visual demonstration of laminar and turbulent flow. It also allows students to investigate the effect of varying viscosity and investigate Reynolds numbers.</p> <p>Specifications: Protective Glass Fibre Housing, Precision Bore Tube of 11 mm inside diameter, 2.5 mm wall thickness, 1015 mm long, Constant Head Tank, 120 mm dia, 300 mm height (approx 3.4 L), with Bell Mouth Entry, Stilling bed consisting of glass beads, Dye Injector Bottle and tube, 250 mL, Heater Module: A free-standing unit to vary and control the water temperature and hence its viscosity.</p>	2
10	<p>Flow Measurement Methods</p> <p>Shows typical methods of measuring the flow of an incompressible fluid, and demonstrates applications of Bernoulli's equation</p> <p>Specifications: Orifice plate: 20 mm diameter with corner tappings, Sudden enlargement: 26 mm to 51.9 mm, Rotameter: Scaled 0 to 210 mm. Includes calibration chart for 0-35 L.min⁻¹ Drawing and dimensions of Venturi meter and Orifice meter silk-screened onto baseplate. Venturi: Material: Clear Acrylic, Upstream diameter 26 mm ± 0.05 mm, Throat diameter 16 mm ± 0.02 mm, Downstream diameter 26 mm ± 0.05 mm, Upstream taper 22.6° Downstream taper 6.4° Coefficient of Discharge nominally 0.93, Manometer: 11 Manometer tubes, Scaled 0 to 380 mm, Maximum flow: 28 L.min⁻¹ All necessary tubing and pipe clips</p>	1
11	<p>Fluid Friction Apparatus</p> <p>A mobile vertical panel featuring various pipe configurations to demonstrate flow and losses in different pipes, fittings and valves. Includes Pitot tube, Venturi and orifice meters for flow measurement</p> <ul style="list-style-type: none"> • Gate Valve (Bronze) • Globe Valve (Bronze) • Ball Valve (Nickel plated Brass) • Smooth Pipe 4mm Diameter Bore • Smooth Pipe 13.6mm Diameter Bore • Smooth Pipe 17mm Diameter Bore • Smooth Pipe 26.2mm Diameter Bore • Roughened Pipe 17mm Diameter Bore (14mm Effective Dia) • Smooth Bend Radius 50mm • Smooth Bend Radius 100mm • Smooth Bend Radius 150mm • Mitre Corner • Elbow 13.6mm Radius • Expansion 26mm to 52mm • Sudden Enlargement 13.6mm to 26.2mm 	1

S. No.	Description	Qty
	<ul style="list-style-type: none"> • Sudden Contraction 26.2mm to 13.6mm • Orifice Meter 20mm Diameter ○ Venturi Meter: d1 = 26mm Diameter, d2 = 16mm Diameter • Inlet Pipe Coloured White - Outlet Pipe Coloured Black • 35 off self sealing pressure tappings • Pitot Static Assembly with traversing mechanism <p>The Inline Strainer with two different plastic filters, one with 1.4 mm diameter holes and the other with 0.5 mm diameter holes. The three valves fitted to the apparatus are typical valves, made from Nickel Plated Brass or Bronze.</p>	
12	<p>Cavitation Demonstration Unit</p> <p>A floor-standing, self-contained apparatus to demonstrate and observe the basic principles of cavitation and its implications on the performance of hydraulic machines and systems</p> <ul style="list-style-type: none"> • Mobile unit that shows students the causes and effect of cavitation • Also allows practical and effective study of flow and pressure in a Venturi meter • Ideal for classroom demonstrations and student experiments • Fully self-contained recirculating apparatus – no additional water supply needed • Includes full instrumentation, including pressure, flow and temperature measurement • Supplied fully assembled – minimal installation needed <p>Specifications Maximum apparatus flow rate: Approximately 45 L.min⁻¹ Maximum pump power: 1 kW Water tank capacity (maximum): 80 L</p>	1
13	<p>Laminar Flow Analysis Table</p> <p>Included: Rubber sheet (from which to cut models) 0.4 m² and 0.76 mm thick, All necessary pipe clips, connectors, pipes and tubing, Dye bottle (600 ml capacity), 500 ml blue or red non-toxic food-grade liquid colouring, clamp and dye, Water jet vacuum pump, Retort rod and clamp, Adaptor, Spare tap, Transfusion clips</p> <p>Specifications: Channel working section (nominal): 300 mm x 250 mm, depth 0.75 mm, Control Valves: 4x 3-way, Number of Dye holes: 17, Number of Sink/Source holes: 4</p>	1
14	<p>Portable Centrifugal Pump Demonstration Unit</p> <p>Bench-top test set that allows students to investigate the operation and performance of a single centrifugal pump and two centrifugal pumps in both series and parallel. Self-contained, compact, bench-top, Includes pressure gauges to measure intake and delivery pressures, Discharge flow measurement, Stroboscope.</p> <p>Specifications</p>	2

S. No.	Description	Qty
	<p>Centrifugal Pumps: 1.6 L.s⁻¹ maximum flow rate in parallel, 235 kPa maximum head in series</p> <ul style="list-style-type: none"> ○ Includes transparent window so that students can see the impeller and cavitation ▪ Pump Impeller diameter 105 mm, Anodised aluminium housing, 172mm diameter, 60mm width • Pump Motors – 2 off single-phase, fixed speed motors (240V 50Hz) ○ Nominal speed 2850 rev.min⁻¹ ○ Power 0.37 kW at 2850 rev.min⁻¹ ○ Power 0.37 kW at 3200 rev.min⁻¹ • 14 L acrylic integral Reservoir • Includes strainer and filter ○ 5 ball valves: 4 off for pump configuration, 1 off for flow rate • 40 mm rotameter with a 10-100 Lpm (1.67 – 16.7 L.s⁻¹) range ○ 3 Bordon gauges: 2 off 0-4 bar (0 – 400 kPa) measuring delivery pressure, 1 off -1 – 0 bar (-100 – 0 kPa) measuring inlet pressure 	
15	<p>Pipe Surge and Water Hammer Apparatus</p> <p>A self-contained unit for teaching the transient effects of pipe surge and water hammer caused by sudden flow rate changes in pipes.</p> <p>Specification:</p> <ul style="list-style-type: none"> • Two separate test pipes: one for pipe surge investigations and one for water hammer investigations • A header tank (reservoir of water) <ul style="list-style-type: none"> ○ includes an internal float valve and an overflow • Includes a clear plastic surge tower connected near its downstream end, and a control valve • 3x pressure transducers <ul style="list-style-type: none"> ○ Pipe Surge – 1x 100 mbar ○ Water Hammer – 2x 30 bar ○ Water Hammer Pipe: Hard-drawn Brass ○ Young's Modulus $E = 103 \times 10^9 \text{ N.m}^{-2}$ (103 Gpa) ○ Inner Diameter $D = 22.2 \text{ mm}$, Wall Thickness $t = 1.6 \text{ mm}$ ○ Cross-sectional Area $A = 0.387 \times 10^{-3} \text{ m}^2$ ○ Approximate distance between transducers = 1.5 m ○ Surge Supply Pipe: Length L between reservoir and surge tower = 3 m <ul style="list-style-type: none"> ○ Inner Diameter = 21.1 mm ○ Cross-sectional Area $A_p = 0.3497 \times 10^{-3} \text{ m}^2$ ○ Surge Tower: Inner Diameter = 44.5 mm, Cross-sectional Area $A_s = 1.5553 \times 10^{-3} \text{ m}^2$ ○ Maximum Measurement Height = 950 mm above pipe centreline ○ Header Tank: Maximum Measurement Height = 700 mm above pipe centreline • Pressure sensor connection leads, Single shot Auto-trigger, Time delay measurement between Channels 1 and 2, Viscous Damping Modelling of experiment data, All necessary pipe clips and tubing 	1

S. No.	Description	Qty
	<ul style="list-style-type: none"> Hydraulics Bench and Data Acquisition System with Software 	
16	<p>Free and Forced Vortex Apparatus</p> <p>A transparent, double-walled vessel that demonstrates the phenomena of free and fixed vortices with measuring devices for calculating the water surface profile</p> <p>Specifications: A low voltage motor rotating a cylindrical vessel about its vertical axis, Includes overheat protection thermostats, Includes variable speed control unit, Acrylic Cylinder 380 mm wide x 180 mm deep, fitted with a removable drain plug, which is retained for forced vortex experiments, A perforated acrylic cylinder 286 mm wide x 180 mm deep which fits inside the larger cylinder for free vortex experiments, Probe traverse to measure the surface profile of the vortex, in mm, Pitot tube traverse to measure the distribution of total head, in mm, Maximum flow rate 8 L.min⁻¹</p>	1
17	<p>Bernoulli's Theorem Demonstration Apparatus</p> <p>A benchtop Venturi tube that allows students to study Bernoulli's theorem by measuring the complete static head distribution along the horizontal tube.</p> <p>Specifications: Flow rate: Nominally 27 L.min⁻¹, Inside diameter of Venturi inlet: 26 mm, Inside diameter of Venturi throat: 16 mm, Inside diameter of Venturi outlet: 26 mm, Pressure tappings: 11, Manometer tubes range: 0 to 400 mm, Hand pump, outlet tubing, pipe clips</p>	2
18	<p>Sediment Transportation Apparatus</p> <p>Includes: Sluice Gate, Venturi Flume, Sharp-crested weir, Broad-crested weir, Pitot Tube, A vibratory Sediment Feeder for dispensing sediment into 80mm wide flow channels.</p> <p>Specifications</p> <ul style="list-style-type: none"> Nominally 2.5 metres long, 250 mm high and 80mm wide Flow Channel Section: Toughened glass channel walls Flow Rate: 0 to 180 litres per minute Tilting: Flume inclinable by -1 to +3 degrees Water Tank: 320 litre tank capacity with level gauge Pump Specifications: Submersible pump, stainless steel shaft, urethane impeller and silicon carbide mechanical seal. Pump power: 0.5kW, Max flow of pump: 12 m³/h, Number of limnimeters: 2 Depth Gauges: 2 Motor: 0.5 kW Induction Motor Pump: Centrifugal. Nominal 2800 rev.min⁻¹ 	2
19	<p>Basic Hydrology Apparatus</p> <p>A self-contained, floor-standing unit consisting of a water reservoir and a tank for sand with overhead spray nozzles that simulate rainfall, both stationary and moving. It is for studying hydrology principles, including</p>	2

S. No.	Description	Qty
	<p>rainfall, throughflow and the movement of water over land and rivers.</p> <p>Specifications</p> <ul style="list-style-type: none"> • Catchment Area <ul style="list-style-type: none"> ○ Stainless steel tank ○ 2 m x 1 m, normal depth of permeable medium 180 mm • Reservoir Tank <ul style="list-style-type: none"> ○ Capacity approx 220 litres • 8x Spray nozzles <ul style="list-style-type: none"> ○ two banks of four ○ with adjustable spray direction ○ Perspex screen to limit the spray • Tilting mechanism to allow the catchment slope to be varied to a 1 in 40 slope ($\approx 1.4^\circ$) • Rotameter to measure flow <ul style="list-style-type: none"> ○ Max flow rate 22 L.min⁻¹ • 2x Wells, 19 mm diameter • Piezometer with 20 piezometer tubes <ul style="list-style-type: none"> ○ Manometer scale 220mm • Sharp-edged rectangular weir with 2-22 litre scale for flow measurement • 2x weirs at either end of the tank with removable portholes • Permeable Medium 	
20	<p>Orifice and Free Jet Flow</p> <p>A constant head device, backboard, set of nozzles and Pitot tube. This apparatus demonstrates vertical flow and horizontal jet trajectories through different orifices (nozzles) and allows students to study the trajectory profiles of water jets from the nozzles when mounted horizontally</p> <p>Specifications: Maximum head: Approximately 365 mm, Maximum flow rate: Nominally 22 litres per minute, Orifice/nozzles: One sharp-edged orifice and three nozzles, Nominal dimensions of cylinder 400 mm x 160 mm diameter. Approx 8 L capacity, a set of 4 interchangeable Orifices (Nozzles), All Nozzles have a 13 mm bore.</p>	1
21	<p>Miscellaneous Laboratory Tools</p> <p>Specifications:</p> <p>A. Socket Set - 1/2" Drive</p> <ol style="list-style-type: none"> 1) 7/16" - 1 1/8" Standard Depth (6 Point) 2) 7/16" - 1 1/8" Deep (6 Point) 3) 10mm - 25mm Standard Depth (6 Point) 4) 10mm - 25mm Deep (6 Point) • 5) Ratchet 6) Breaker Bar 7) Extension 3",6",12" <p>B. Socket Set - 3/8" Drive</p> <ol style="list-style-type: none"> 1) 5/16" - 3/4" Standard Depth (6 Point) 	Lump sum

S. No.	Description	Qty
	<p>2) 3/8" - 3/4" Deep (6 Point) 3) 9mm - 19mm Standard Depth (6 Point) 4) 9mm - 19mm Deep (6 Point) 5) Ratchet 6) Extension - 3",6",12",18" 7) Universal Joint 8) Fractional Universal Impact Socket Set 3/8" - 3/4"</p> <p>C. Combination Wrenches 1) 1/4" - 1" Standard 2) 7mm - 24mm Metric</p> <p>D. Hex (Allen) Wrenches 1) 050" - 3/8" Fractional 2) 2 mm - 7mm Metric</p> <p>E. E. Screw Drivers 1) Blade Type 2) Stubby 3) 1/4" x 6" 4) 1/4" x 9" 5) 3/8" x 9" 6) 3/8" x 16" 7) Offset 8) Phillips 9) #2 Stubby 10) #1Tip 11) #2Tip 12) #3Tip 13) Offset</p> <p>F. Four-piece Pliers set 1) Slip Joint 8" 2) Long Nose 8" 3) Diagonal Plier 7" 4) Lineman Plier 8"</p> <p>G. Pipe Wrenches 10" and 14"</p> <p>H. 3-piece Adjustable Wrenches 8" 10" 14"</p> <p>I. Hammers 1) 16 oz. Curved Claw Hammer 2) 16 oz. Ball Pen</p> <p>J. Hack saw</p>	

2) MATERIAL TESTING LAB, CIVIL ENGINEERING DEPARTMENT (Lot Wise Only – Import Purchase)

Imported items must be; of advanced technological countries i.e. UK, USA, Japan and Western European Countries

S. No	Equipment Name and Specification	Qty
1	<p>Servo Hydraulic Universal Testing Machine (UTM) 500 KN</p> <p>Rack & Pinion Closed Crossheads, Proterm handheld controller, Tensile Grip, Wedge; Solid Flat, Lever, Width 56mm, Tensile Grip, Wedge; Solid Vee, Lever up to 44mm dia. Extensometer, SG; 50mm G.L. 50%, Model Strain Module for Strain Gauge Extensometer, Compression Plates 9" diameter, Transverse Flexure Tool, 30" span – 6" wide, Double Shear Tool, Shear Tool Cutter Blades for up to 12mm dia samples, Materials Testing Primary Platform Software, Metals Library Software.</p> <p>A. Control System. A. Through the handheld terminal, this system operates in the manual mode, which can be configured via a menu-driven user interface. A keypad provides functionality for loading and unloading in the manual mode, for pump start/stop, return and max values. B. Closed loop control via the handheld terminal and digital display <i>without</i> the use of a PC system/controller. If the servo control system and high-resolution encoders are purchased, the operator may enter two (2) preset speeds into the handheld controller. These speed(s) are then constantly monitored and regulated, eliminating operator variability. C. PC/Software/Control option – If the servo and PC/Software/Control options are ordered, tests can be precisely controlled using load, position or strain (assuming an instrument is used). You may use the above variables in rate or hold function (ie load rate, stress rate, strain rate, crosshead rate or hold values of load, stress, strain or position values). Tests can be started in one control mode and changed to another mode (ie crosshead speed to strain rate to yield and back to crosshead speed to failure)</p> <p>B. Load Frame. 1. Load Frame Capacity: 600 kN in tension and compression. 2. 32" (813mm) nominal maximum tensile specimen size. 3. 24" (610mm) max vertical clearance in compression space without tooling. 4. Horizontal clearance 20" (508mm) between screws. 5. Load frame shall be a separate unit from the control/indication system to minimize shock transfer. 6. Hydraulic stroke 6" (152mm).</p> <p>C. Indicating System – Microprocessor Based. 1. Strain gage pressure transducer weighing system. a. Must be easily removable for replacement or repair without disassembly of machine. 2. Three display channels. a. Capable of displaying 3 channels of readout simultaneously (i.e. load, strain, position – when appropriate signal conditioning modules are installed). 3. Numeric mode has 0.4" high characters. If the position instrumentation (high resolution encoder) and signal conditioning modules are ordered, the speed will be displayed in addition to the above 3 channels. 4. If the position instrumentation (high resolution encoder) and signal conditioning</p>	1

	<p>modules are ordered, the speed will be displayed in addition to the above 3 channels. 5. Serial port for data transmission or connection to a power. 6. Must be able to recall values from the last test. 7. Operating temperature 0 to +40 deg C non condensing. 8. Non volatile memory for system configuration. 9. Calibration digitally stored in "modules". 10. Conforms to ASTM E4, E83 and other international standards. 11. Accuracy must be: a. +/- 0.5% of indicated load, or +/- 1 digit, whichever is greater. b. Typical resolution of at least 100,000 to 1. c. Calibrated from 0.2% to 100% of the machine capacity. 12. Built-in sample break detector with the ability to store peak values when activated. 13. RS232 built in for high speed bi-directional interface for data transfer or control and allowing interface with data system</p> <p>Software able to perform: Tab enabled navigation for ease of operation, Ability to consolidate & customise test reports, Ability to customise software screen layout to suit operator, Live real time curve display, Curve regeneration option post test, Offline operation for simulation purposes, Ability to create customise methods, Automated pass/fail control, Ability to export test data, Security enabled password protection to restrict operators from changing settings.</p>	
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3) CONCRETE LAB, CIVIL ENGINEERING DEPARTMENT Lot Wise Only – Local Purchase)

S. No	Equipment Name and Specification	Qty
1	Briquette Apparatus AASHTO T132	1
7	Heavy Duty Balance 300 Kg Work Range	1
10	Balance 6 Kg (Electronic with 01 gram accuracy) Readability: 0.01g, Pan Size: Φ116mm, AC Power Supply	2
14	Briquette Moulds AASHTO T132	12
15	Cylinder Capping Retainers (couple) 6"×12" (with 60 shore neoprene pads couple)	2
16	12" dia ASTM Sieve Set (Complete) 100 mm (4"), 90 mm (3 ½"), 75 mm (3"), 63 mm (2 ½"), 53 mm (2.12"), 50 mm (2"), 45 mm (1 ¾"), 37.5 mm (1-½"), 31.5 mm (1 ¼"), 26.5 mm (1.06"), 25 mm (1"), 22.4 mm (7/8"), 19 mm (¾"), 16 mm (5/8"), 13.2 mm (.530"), 12.5 mm (½"), 11.2 mm (7/16"), 9.5 mm (3/8"), 8 mm (5/16"), 6.7 mm (.265"), 6.3 mm (¼"), 5.6 mm (No. 3 ½), 4.75 mm (No.4), 4 mm (No.5), 3.35 mm (No. 6), 2.8 mm (No. 7), 2.36 mm (No.8), 2 mm (No.10), 1.7 mm (No. 12), 1.4 mm (No. 14), 1.18 mm (No.16), 1 mm (No. 18), 850 µm (No. 20), 710 µm (No. 25), 600 µm (No. 30), 500 µm (No. 35), 425 µm (No. 40), 355 µm (No. 45), 300 µm (No. 50), 250 µm (No. 60), 212 µm (No. 70), 180 µm (No. 80), 150 µm (No. 100), 125 µm (No. 120), 106 µm (No. 140), 90 µm (No. 170), 75 µm (No. 200), 63 µm (No. 230), 53 µm (No. 270), 45 µm (No. 325), 38 µm (No. 400)	3
21	Sieve Shaker The Electromagnetic Digital Sieve Shaker performs a vertical sieving motion and y removing the upper plate it can also be used as a vibrating table for one concrete specimen, Sieve Capacity: 12 pieces of 200mm sieves + pan and cover, 8 pieces of 300mm or	1

	315mm sieves + pan and cover, Dimensions: 495 x 405 x 945mm, Weight: 30Kg, Power: 400W	
28	Miscellaneous Tools, Safety Tools	Lump Sum

4) PUBLIC HEALTH LAB, CIVIL ENGINEERING DEPARTMENT Lot Wise Only – Local Purchase)

SR	ITEMS WITH FULL SPECIFICATIONS	QTY
01	<p>Apera Portable pH/mV/Temp Meter</p> <p>IP57 waterproof rating. Apera Portable pH Meter Kit with GLP Data Logger and USB Data Output GLP Data management (500 groups of data storage), USB data output. Ideal for use in harsh environments — IP57 Waterproof rating, silicone socket protector and grip cover protect the instrument from general impact. Quick and easy 1 to 3 points auto. pH calibration with calibration reminder and last calibration check; Automatically recognizes pH standards of 1.68, 4.00, 7.00, 10.01, 12.45. Built-in self-diagnosis ensures pH calibration will be performed correctly and guides you on how to fix common problems. Standard BNC connector, compatible with Apera's LabSen® Series professional pH electrodes for other applications. Range -2.00 to 16.00 pH Includes: Portable/Handheld Meter, 201T-F pH Electrode, Software Flash Drive, USB cable, pH calibration solutions, screw driver, Users manual and carrying case.</p>	01
2	Battery Dry Alkaline Manganese MN1500 (AA)	1
3	<p>Laboratory touch screen multi-parameter water quality analyzer</p> <p>Use spectrophotometry to quickly and directly measure chemical oxygen demand (COD), ammonia nitrogen, total phosphorus, total nitrogen, suspended solids, color, turbidity, heavy metals, organic pollutants, inorganic pollutants, etc. in water in accordance with industry standards. item indicators. 7-inch 1024*600 touch screen, 360° rotating colorimetry mode, full English interface, convenient and quick operation, and supports self-created curves. Colorimetric method: 16mm/25mm tube & 10mm/30mm cell Resolution: 0.001Abs Operating system: Android Display: 7 inch 1024*600 touch screen Storing data: 5000 Rated voltage: AC 220V Printer: Built-in thermal printer</p>	

04	<p>TURBIDITY METER Range 0.00 to 50.00 NTU, 50 to 1,000 NTU * NTU : Nephelometric Turbidity Unit* Auto range Resolution 0.01 NTU/ 1 NTU Accuracy $\pm 5\%$ F.S. or ± 0.5 NTU, which ever is greater. Light source LED, 850 nm. Detector Photo diode Standard Meet ISO 7027. Response time Less than 10 seconds. Sample volume needed 10 mL. Power Supply DC 1.5 V battery (UM4, AAA) x 6 PCs, Accessories Testing bottle with 0 NTU standard solution.....1 PC Included Testing bottle with 100 NTU standard solution..... 1 PC Empty testing bottle..... 2 PCs Clean cloth.....1 PC Clean solution (Distill water).....1 bottle Hard carrying case, CA-08.....1 PC</p>	01
	<p>Biochemical oxygen demand Direct reading of detection concentration: range 0-4000mg/L, BOD value can be displayed directly without conversion; One-key batch testing: The measuring bottle operates independently, and the host starts batch testing with one click; Culture bottle capacity: 580mL Display resolution: 0.1mg/L<10mg/L;1mg/L\geq10mg/L Measurement sample 6 pcs Measurement period 5 days, 7 days Instruction Manual, Power: 230VAC, 50Hz. BOD accessories such as 6 Nos BOD Bottles, 580mL Amber Glass, 6 rubber gasket, 6 stirring rods, 6 plastic cups, clip etc.</p>	01
06	<p><u>Water Safety Kit Basic</u> The kit combines microbiological and simple chemical methods of analysis. Perform microbiological membrane filtration and apply chemical test equipment directly on-site - rapidly & with reliable results. Conductivity 0 - 20 mS/cm ; Turbidity 30 - 400 NTU ; Aerobic bacteria (TVC)/ coliforms ; Aerobic bacteria (TVC)/E.Coli, coliforms ; pH 6.8 - 8.2 ; Chlorine 0.1 - 3.0 mg/L Cl₂</p>	01
07	<p>Biological Microscope halogen bulb or LED. Stage 135x125mm. Excursion XY: 75x35mm (div 0,1mm). Coaxial knobs on right side. Condenser Abbe N.A. 1,25. Equipped with diaphragm and filter set. Height and centering are adjustable. Achromate objectives, 4x, 10x, 40x, 100x oil 10X wide field eyepieces Halogen illumination, abbe condenser, Mechanical stage, Illumination LED or Halogen bulb Power 220V, 50Hz.</p>	01

	<p>Laboratory fast COD analyzer to get result in 20 minutes</p> <p>Technical Parameters</p> <table> <tr> <td>Item</td> <td>COD high range</td> <td>COD low range</td> </tr> <tr> <td>Range</td> <td>20-10000mg/L (subsection)</td> <td>2- 150mg/L (subsection)</td> </tr> <tr> <td>accuracy</td> <td colspan="2">COD<50mg/L,error≤±10%; Error≤±10%</td> </tr> <tr> <td>limits of detection</td> <td colspan="2">0.1mg/L 0.1mg/L</td> </tr> <tr> <td>Determination time</td> <td>20min</td> <td>20min</td> </tr> <tr> <td>Batch processing</td> <td>16</td> <td>16</td> </tr> <tr> <td>Repeatability</td> <td colspan="2">≤±5%</td> </tr> <tr> <td>Lamp life</td> <td colspan="2">100 thousands hours</td> </tr> <tr> <td>Optical stability</td> <td colspan="2">≤±0.005A/20min</td> </tr> <tr> <td>Anti-chlorine interference</td> <td><1000mg/L</td> <td>no influence</td> </tr> <tr> <td></td> <td colspan="2">;<100000mg/L Optional</td> </tr> <tr> <td>Colorimetric method</td> <td colspan="2">Cuvette/Tube</td> </tr> <tr> <td>Data storage</td> <td colspan="2">12000</td> </tr> <tr> <td>Curve data</td> <td colspan="2">180</td> </tr> <tr> <td>Display mode</td> <td colspan="2">LCD(Resolution 320*240)</td> </tr> <tr> <td>Communication interface</td> <td colspan="2">USB /Infar-red (optional)</td> </tr> <tr> <td>Power supply</td> <td colspan="2">AC220V±10%/50Hz</td> </tr> </table> <p>16 positions touch screen fast laboratory COD reactor</p> <p>Display: 3.5 inch color touch screen</p> <p>Positions: 16/25</p> <p>Heating rate: To 165 °C within 10 minutes</p> <p>Digestion procedure: 15</p> <p>Digestion temperature: (40~190) °C</p> <p>Temperature accuracy: ±0.5°C</p> <p>Timing accuracy: 0.2 seconds/hour</p> <p>Digestion pipe diameter: Φ16mm</p> <p>Digestion capacity: (0~12) mL</p> <p>Height of digestion tube: 150mm</p> <p>Heating liquid depth: 80mm</p> <p>COD chemical reagent * 50 test. Precast round tube vial reagents 20-15000mg/L</p> <p>COD chemical reagent * 50 test. Precast round tube vial reagents 20-150mg/L</p> <p>COD chemical reagent * 50 test. Precast round tube vial reagents 200-15000mg/L</p> <p>COD chemical reagent * 50 test. Precast round tube vial reagents 0.7-40mg/L</p>	Item	COD high range	COD low range	Range	20-10000mg/L (subsection)	2- 150mg/L (subsection)	accuracy	COD<50mg/L,error≤±10%; Error≤±10%		limits of detection	0.1mg/L 0.1mg/L		Determination time	20min	20min	Batch processing	16	16	Repeatability	≤±5%		Lamp life	100 thousands hours		Optical stability	≤±0.005A/20min		Anti-chlorine interference	<1000mg/L	no influence		;<100000mg/L Optional		Colorimetric method	Cuvette/Tube		Data storage	12000		Curve data	180		Display mode	LCD(Resolution 320*240)		Communication interface	USB /Infar-red (optional)		Power supply	AC220V±10%/50Hz		<p>01</p> <p>01</p> <p>01</p> <p>01</p> <p>01</p> <p>01</p> <p>01</p> <p>01</p> <p>01</p> <p>01</p> <p>01</p>
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09	<p>Multi-parameter pH/mV/Cond/ measuring device</p> <p>Apera 7-in-1 Portable Handheld pH/Conductivity/DO Meter Kit</p> <p>Apera SX736 is designed for lab-grade measurement of up to 7 water quality parameters in the field, including pH, DO (dissolved oxygen),</p>	01																																																			

	<p>conductivity, TDS, salinity, and resistivity. It is suitable for general water solutions' applications such as water treatment, groundwater, surface water, hydroponics, environmental monitoring, aquaculture, aquarium, beverage making, etc.</p> <p>Measurement range (-2.00 to 19.99) pH Measurement range (mV/ORP/EH) -1999 mV to 0 to 1999mV Measurement range Conductivity: (0.00 to 19.99)μS/cm (20.0 to 199.9)μS/cm (200 to 1999)μS/cm (2.00 to 19.99) mS/cm (20.0 to 199.9) mS/cm TDS: (0 to 100) g/L; Salinity : (0 to 100) ppt Resistivity: (0 to 100) MΩ·cm</p> <p>Included: , PH, Conductivity electrodes, All the necessary buffers and accessories are included in the rugged carrying case.</p>	
10	Digital Water Bath ,	01
11	<p>Heating Incubator Model Temp range: RT+5~80°C Capacity: 222L Stainless steel inner liner</p> <ul style="list-style-type: none"> ● 304 stainless steel, mirror polishing, strong anti-corruption ability. ● Large arc angle design, no dead angle, easy cleaning and maintenance. ● Adopting direct heating system, the heating speed is fast and the control precision is high. ● PID control technology, high control precision and small temperature fluctuation. ● Available in Chinese and English menus to meet different language needs, with °C / °F conversion. ● The height of the shelf is adjustable to meet different cultivation needs. ● Professional stacking foot design, the machine can be stacked, saving lab space and improving the use efficiency (same Specification <p>Power Supply: AC220V,50Hz</p>	01
12	<p>autoclave is suitable for sterilization cycles at 121°C and 1 atm, according to 97/23/CE European Directive. External anti-acid painted structure, made in steel Backlit LCD display for controlling and handling the sterilization program Vertical sterilization chamber in stainless steel, 23-liter capacity Stainless steel lid with a safety and easy-to-use mechanical closure Manometer for controlling the working pressure in the chamber Automatic safety valve Automatic steam release at the end of the cycle External cock for emptying the residual water from the chamber Safety adhesive on the lid to warn about high temperatures during the cycle Safety water lack sensor in the chamber, with manual reset Sterilization time can be set and customized Back-lit ON/OFF switch and warning LEDs for heating resistor and water lack</p>	01

18	BOD bottle 300ml	10
19	Reagent Bottle Borosilicate glass, 250ml with blue cap.	10
20	Miscellaneous lab tools as per lab experiments	Lump sum
21	Miscellaneous Chemicals as per lab experiments	

5) SURVEYING LAB, CIVIL ENGINEERING DEPARTMENT Lot Wise Only – Local Purchase)

S.No	Equipment Name and Specification	Qty
1	Plane Table Complete set with all accessories	1
2	Chains 100 ft	03
3	Tapes (100ft)	2
4	Compass (Prismatic) with Tripod stand	8
16	Trough Compass	5
17	Altimeters in Leather Case	5

6) SOIL MECHANICS & HIGHWAY LAB, CIVIL ENGINEERING DEPARTMENT Lot Wise Only – Local Purchase)

S. No.	Description	Qty
1	<p>Casagrande Liquid Limit Device Motorised Liquid Limit Device (Casagrande) ASTM – AASHTO 220-240 V 50-60 Hz The Motorised Liquid Limit Apparatus (Casagrande) are used to determine the moisture content at which clay soils pass from plastic to liquid state. The devices consist of an adjustable crank and cam mechanism, a blow counter and a removable brass cup fitted on the base. Different models with the same shape but with different base and cup weights are available according to the required specifications. Manual and Motorised versions are available. All Liquid Limit Devices supplied complete with a plastic grooving tool. Suitable type of grooving tools should be ordered separately.</p>	01
2	<p>Mould 152 mm dia × 127 (h) mm CBR Mould ASTM / AASHTO, plated steel mould body with 6" (152.4 mm) dia. x 7" (177.8 mm) height, supplied complete with extension collar and perforated base plate CBR Mould ASTM/AASHTO, plated steel mould body with 6" (152.4 mm) dia. x 7" (177.8 mm) height. Supplied complete with extension collar and perforated base plate. Spacer Disc with T handle ASTM, 150.8 mm dia x 61.4 mm high. Annular Surcharge Weight ASTM, 2.27 kg Slotted Surcharge Weight ASTM, 2.27 kg CBR Solid Base Plate ASTM Straightedge 300x30x5 mm Filter Paper for CBR Test No: 5 x 150 mm dia. ASTM (Pack of 100) Filter screen, 144 mm dia. 150 µm mesh ASTM Spacer Disc with T Handle ASTM, 150.8 mm dia. x 61.4 mm height Annular Surcharge Weight ASTM, 2.27 kg</p>	04

S. No.	Description	Qty
	Slotted Surcharge Weight ASTM, 2.27 kg CBR Solid Base Plate ASTM Straightedge 300 x 30 x 5 mm Filter Paper for CBR Test No: 5 x 150 mm dia. ASTM (Pack of 100) Filter screen, 144 mm dia. 150 µm mesh ASTM	
3	Sand Absorption Cone and Tamper Sand Cone Set 6.5" Complete with double cone, 5 lt plastic jar, base plate with flanged hole	02
4	Proctor Penetrometer ASTM D 1558 Used for establishing the moisture-penetration resistance relation of fine grained soils. Supplied complete with TS-0666 Needle Set (28.55, 24.79, 20.22, 16.54, 12.83, 9.07, 6.40, 5.23 ve 4.52 mm dia. 9 pcs. needles.) and special wooden case.	01
5	Sedimentation by the Hydrometer Method (with all standard accessories) Hydrometer Test Set is used to determine the particle size distribution of very fine materials such as silt and clay. The soil dispersion mixer for hydrometer test method, operates at over 13,000 r.p.m, includes dispersion cup, stirring paddle, automatic switch-on by positioning bowl, 100 W power consumption. The hydrometer bath, circulation unit, ambient to 35°C working temperature, 50 L capacity tank with 8 pcs. sedimentation cylinder capacity. Hydrometer 151H (11" long, 0.995-1.038 g/ml specific gravity by 0,001 g/ml division, calibrated at 20°C) and Hydrometer 152H (11" long, -5 - +60 g/L in 1g/L division, calibrated at 20°C) should be ordered separately.	05
6	High Speed Stirrer High speed stirrer, 15.000 rpm, complete with cup, paddle, anti-splash baffle, for dispersing soil particles in water. 230V 1ph 50Hz	02
7	Oven: Capacity 100 liters, Shelves 02, Guides 5, Watts 1200 The Laboratory Oven have been designed for drying asphalt, soil, rock, concrete, aggregate or similar materials. From ambient to 250°C temperature range with a precision of ±2 °C. The interior is manufactured from stainless steel and the exterior is robustly constructed from sheet steel finished in powder coated paint. All models are fan circulated (forced convection), fitted with direct reading digital control unit and equipped with an analogue over-temperature protection thermostat. Laboratory Ovens are supplied complete with 2, 3, 4 or 5 shelves according to the capacity.	01
8	Hand-Operated Universal Extruder Hand Operated Hydraulic Specimen Extruder, Vertical Type, 60 kN Capacity Standard EN 13286-2; EN 13286-47; EN 12697-30; AASHTO T134; AASHTO T180; AASHTO T193; AASHTO T245; ASTM D698; ASTM D1557; ASTM D1883; ASTM D1559; BS 1377-4; BS 1924-2; BS 598-107 Description for the manual extrusion of specimens from standard BSP (U4) threaded sample tubes 100 mm, 4", 150 mm and 6 " Compaction	01

S. No.	Description	Qty
	Moulds, CBR and Marshall Moulds. The extruder has 60 kN extrusion force and 650 mm ram travel. Supplied complete with 2 pcs. adaptors for Ø100 mm (4") and Ø150 mm (6") dia. moulds.	
9	Solution Balance (Capacity 20Kg, Accuracy 0.1 gm) Maximum Capacity: 60 lb (30 kg) Readability: 0.002 lb (1 g) Readability (Certified): 0.02 lb (10 g) Platform Size (LxW): 8.9 in x 11.8 in (225 mm x 300 mm) Battery Life: 210 Hours with Rechargeable Battery Communication: Ethernet (Available as an Accessory);USB (Available as an Accessory);RS232 (Included);2nd RS232 (Available as an Accessory) Display: Dual LCD with white LED backlight + 3 LED	01
10	Digital Balance (Capacity 6 Kg, Accuracy 0.01 gm) Maximum Capacity: 15 lb (6 kg) Readability: 0.0002 lb (0.1 g) Platform Size (LxW): 280 mm x 280 mm Legal for Trade: EC Type Approvable Power: AC Power (Included); Rechargeable Battery (Not Included) Battery Life: 12 Hours with Rechargeable Battery Communication: USB (Included); RS232 (Included);2nd RS232 (Available as an Accessory);Ethernet (Available as an Accessory) Display: 4.3"/10.9 cm TFT Graphic LCD In-use cover: Included Linearity ±: 0.2 g Net Weight: 6.8 kg Outputs: 3 In/4 Out digital I/O Platform Construction: Stainless Steel Protection Rating: IP54 Second Scale Input: Yes Tare Range: To capacity by subtraction	01
11	Digital Balance (Capacity 1 Kg, Accuracy 0.01 gm) Maximum Capacity: 6 lb (3 kg) Readability: 0.00002 lb (0.01 g) Platform Size (LxW): 240 mm x 240 mm Battery Life: 9 Hours with Rechargeable Battery Second Scale Input: Yes Communication: USB (Included); RS232 (Included);2nd RS232 (Available as an Accessory);Ethernet (Available as an Accessory) Display: 4.3"/10.9 cm TFT Graphic LCD Internal Calibration: AutoCal™ - Automatic In-use cover: Included Legal for Trade: EC Type Approvable Linearity ±: 0.02 g Net Weight: 7.2 kg Outputs: 3 In/4 Out digital I/O Platform Construction: Stainless Steel	01
12	Los Angeles Abrasion Machine (with abrasive charges, accessories and spare parts) Los Angeles Abrasion Machine, 220-240 V 50 Hz	01

S. No.	Description	Qty
	<p>Description</p> <p>The Los Angeles Abrasion Machine is used for determination of the aggregates resistance to fragmentation. The machine consists of an electronic control unit and a rolled steel drum having an inside diameter of 711 mm and internal length of 508 mm. The drum is rotated at a speed of 31-33 r.p.m. The internal shelf provided with the machine conforms to ASTM, AASHTO and EN standards. The machine is equipped with an automatic counter, when the preset revolution count is reached, the machine will stop automatically. The drum is equipped with an interlock device which allows the operator to lock the drum into position for easy loading/unloading of the sample. A steel tray is supplied with the machine for easy discharge of specimen and abrasive charges. The standard model can be supplied with a safety/noise reduction cabinet. The cabinet is lined internally with soundproofing material to reduce sound level conforming to CE directives. The cabinet must be ordered with the Los Angeles machine if required, as the electronic control unit will be installed on the safety cabinet at the time of manufacture. The cabinet is equipped with an electric safety device which automatically stops the rotation of the drum when the door is opened, conforming to CE directives. • Abrasion balls and 1.6 mm, 10mm, 11.2mm (or 12.5mm) and 14 mm sieves acc. to EN standard • Abrasion balls, 1.7 mm(No.12) sieve and other sieves which change depending the grain size acc. to ASTM and AASHTO standards</p>	
13	<p>Unconfined Compression Machine Hand Operated</p> <p>Multiplex Machine with Servo Motor and BC100 TFT Graphics Data Acquisition and Control System, 50 kN Comes With: - Compression Platens, used to perform uniaxial and unconfined compression tests Multiplex Machine is used to make Uniaxial, CBR and Marshall Tests. 50 kN capacity Multiplex Machine is equipped with a servo motor and BC100 TFT graphics data acquisition and control system and capable of doing test with the speed range of 0,00001 mm/min to 51 mm/min suitable for CBR, Marshall, Triaxial and Uniaxial Tests and similar tests with appropriate accessories. The machine is also capable of doing load controlled tests. TM-0108 Multiplex Machine is composed by a robust and compact two column frame with adjustable upper cross beam. Supplied complete with: Load Cell, 50 kN and Displacement Transducer, 25 x 0,001 mm. Test accessories should be ordered separately according to the test. Specification: Test Speed: 0,00001– 51 mm/min Capacity kN: 50</p>	01
14	<p>Electronic Apparatus for Direct Shear Testing</p> <p>Automatic Direct / Residual Shear Test Machine, 220-240 V 50-60 Hz Comes With: -</p> <ul style="list-style-type: none"> • Shear Box Assembly, 60 x 60 mm • Specimen Cutter, 60 x 60 mm • Extrusion Dolly, 60 x 60 mm • Shear Box Assembly, 100x100 mm 	01

S. No.	Description	Qty
	<ul style="list-style-type: none"> • Specimen Cutter, 100 x 100 mm • Extrusion Dolly, 100 x 100 mm • Slotted Weight Set, 50 kg (4 x 10 Kg + 1 x 5 Kg + 2 x 2 Kg + 1 x 1 Kg) <p>The test covers the determination of consolidated drained shear strength of a soil material in direct shear. TS-2060 Automatic Direct / Residual Shear Test Machine is motorized and floor mounted. Supplied with carriage assembly load hanger and integral 9:1, 10:1 and 11:1 lever loading device as standard. The beam loading device which is used to amplify the vertical load on the shear box assembly can receive up to 50 kg of weight. The total load on the specimen can reach up to 5 kN (5000 N). The machine accepts 60 mm square, 100 mm square, 60 mm dia. round, 100 mm dia. round and 2.5 inc. dia. round shear box assemblies. All shear box assemblies are designed to contain water that surrounds the specimen. The Assemblies consist of a shear box with a rigid wall square or round hole complete with a vertical loading pad grooved back face, a grooved retaining plate, 2 pcs. porous plates, 2 pcs. plane grids and 2 pcs. perforated grids. The shear machine is driven by high resolution servo-motor and gear box assembly. Speed range is fully stepless variable over the range 0.00001 to 9.99999 mm/min for both directions (forward and reverse). After test the reverse speed is 10 mm/ min.). 5 kN load cell is used for load measurement. 10 x 0.001 mm and 25 x 0.001 mm sensitivity linear potentiometric transducers are used for vertical and horizontal displacement measurements respectively. Displacement limits are controlled by a limit switch. Shear Box Assembly, Slotted Weight Set and other optional accessories including specimens cutter and extrusion dolly.</p>	
15	<p>Glass Wares Including Beakers, Cylindrical Measures Borosilicate Glass Beakers: 50ml, 100ml, 250ml 500ml 1000ml (05 Each Quantity) Volumetric Glass Flask: 50ml, 100ml, 250ml, 500ml, 1000ml (05 Each Quantity) Graduated Glass Measuring Cylinder: 50ml, 100ml, 250ml, 500ml, 1000ml (05 Each Qty)</p>	01
16	<p>Sieve Shaker Electromagnetic Digital Sieve Shaker for 200 mm (8”) to 300/315 mm Sieves, 220-240V, 50-60Hz The Electromagnetic Digital Sieve Shaker performs a vertical sieving motion and by removing the upper plate it can also be used as a vibrating table for one concrete specimen. The vertical sieving motion is provided by a very effective electromagnetic unit which is designed to obtain the best results with sand and aggregates. Supplied complete with timer.</p>	01
17	<p>Standard Moisture Tester (100 g Max. Sample) The Speedy Moisture Tester is used to determine the moisture content of soils, sand and fine aggregates in the field. It is an easy and portable method. The amount of gas, which is given off when water and calcium carbide are mixed and react, is directly proportional to the amount of water present in the sample and results in percentage moisture are taken from a pressure gauge. This model is used for moisture</p>	01

S. No.	Description	Qty
	determination of a 20 g specimen with 20% maximum moisture content.	
18	<p>Blaine Fineness Apparatus The Blaine Air Permeability Apparatus is used to determine the fineness of Portland cement, limes and similar powders expressed in terms of their specific surface.</p> <p>Supplied With: -</p> <ul style="list-style-type: none"> • U Manometer Tube • Manometer Liquid • Test Stand • Rubber Aspirator • Cell with Perforated Disc and Plunger • Plastic Funnel • Filter Paper, 100 pcs • Reference Cement 	02
19	<p>Three Test Bay Machine (with all accessories)</p> <ul style="list-style-type: none"> • Fully automated testing from Saturation, Consolidation, and Shearing – without user intervention in between. • Compact and standard Triaxial System Options available. • Advanced Stress path control, K0, anisotropic, and Slow Cyclic up to 0.1 Hz (amplitude-dependent). • The system is provided with 9 Analogue and 1 Digital Channel Input. • Built-in logger allowing high-speed sensor data conversion (24-bit, up to 5000 samples/s). • Closed Loop control for Displacement, Load, Speed mode, and Pressure. • Flexibility to adjust PID for a variety of samples, ranging from stiff to soft soils. • Auto engage function to easily apply seating load. • Soft limits adjustable for all channels. • Standalone Use via Touchscreen display with data export to PC. • Built-in live data table and graphs. • Built-in auto protection for mechanical limits & sensor limits. • Auto reverse from limit switch activation. • Multiple Units can be controlled from a single PC via a LAN or Ethernet/USB hub. • USB or Ethernet connectivity for PC Control. <p>50kN Advanced Load Frame, Clisp Studio Triaxial Software, Triaxial Cell (Static) for up to 76mm dia samples 3.5MPa, Top Cap 70mm, Base Pedestal 70mm, Sample Preparation Kit for 70mm dia Samples (Triax), Top Cap 50mm (Domed), Base Pedestal 50mm, Sample Preparation Kit for 50mm dia Samples (Triax), S-Beam Load Cell, 10kN with 2 meter cable and DIN plug, Adapter set to use 10/20kN S-Beam load cell for Trx (LSCT), Displacement transducer, 50mm with cable & 5-pin DIN plug, Pressure Transducer 20 Bar (2MPa) PRO Sensor with 5-pin DIN, De-airing Block with valve for pressure transducer, Automatic Solenoid Valve with quick release connection, Dual Automatic Pressure/Volume controller Pro, 3500kPa/250cc, De-Aired Water Tank, 19 litre capacity, Wall Mounted, Vacuum Pump 2 Stage 40L/Min (1.4CFM) with Hose</p>	01

S. No.	Description	Qty
	Connector, APC Water Distribution Panel 2-way, Installation Kit for Triaxial System Including Tools.	
20	<p>C.B.R. Testing Machine - 50 kN (Test speed 1.27 mm (0.05")/ minute) with all accessories CBR Test Machine with Load Ring, 50 kN capacity, 220-240 V 50-60 Hz Designed for performing laboratory evaluation of the CBR value of highway sub bases and subgrade and for the determination of strength of cohesive materials which have maximum particle sizes less than 19 mm (3/4"). The TS-0852 is designed to load the penetration piston into the soil sample at a constant rate to measure the applied load and piston penetration at predetermined intervals. The machine is designed to be mounted on a suitable bench and comprises of a robust and compact two column frame with adjustable upper cross beam. The frame has 50 kN capacity. Two test speeds are provided 1.0 mm/ min for BS and 1.27 mm/min for ASTM/EN/AASHTO tests. This main feature allows the user to perform tests complying to BS or ASTM/EN/AASHTO standards with the same machine. Loading and unloading are down from the front panel by UP/ DOWN buttons. Unloading speed is adjusted 5 mm/min for easy re-testing.</p> <p>Supplied With The CBR Test Machine is supplied complete with:</p> <ul style="list-style-type: none"> • Load Ring, 50 kN • Digital Gauge with Connection Part, 25x0.01 mm • Penetration Piston 	01
21	<p>Consolidation Cells Sample Dia. 50.47 mm</p> <p>Consolidation (Oedometer) Test Set Front Loading Oedometer (Consolidation)</p> <p>Consisting On: -</p> <ul style="list-style-type: none"> • Consolidation Cell for High Pressure, Ø 50 mm • Bench for Consolidation, 3 Oedometer Capacity • Calibration disc for 50 mm dia. consolidation cell (TS-0307), stainless steel • Static Unilogger, 4 Channel Data Acquisition Unit • Digital Dial Gauge 25 x 0.01 mm, LCD display, data output (Qty 03) <p>Front Loading Oedometer (Consolidation) The Front Loading Oedometer is rigidly constructed to ensure minimum frame distortion. The frame is designed to load the specimen through a lever arm assembly and one of three alternative beam ratios as 9:1, 10:1 and 11:1. The beam is fitted with a counter balance weight and beam support jack. The cell platform will accept the complete range of our consolidation cells and is fitted with a central spigot to ensure accurate centering of the cell under the loading. Our fixed ring consolidation cells are manufactured from corrosion- resistant materials and conform to the requirements of the relevant standards. An integral water reservoir is incorporated in the cell which allows the specimen to be inundated when required. All cells are supplied complete with upper and lower porous disc, pressure pad and cutting (specimen) ring.</p>	01

S. No.	Description	Qty
	<p>Specifications Application: High Pressure Specimen Diameter: 50 mm Specimen Area: 1963 mm² Beam Ratio: 10:1 Total Load: 64 Kg Stress: 32 kg/cm² Stress for 1 kg: 0.5 kg/cm²</p>	
22	<p>Vibrating Hammer Compaction (Electric Hammer Compactor with Accessories and Spare Parts)</p> <p>Automatic Soil Compactor, 220-240 V 50 Hz Comes With: - Modified Proctor Mould ASTM Automatic Soil Compactor is designed to compact specimens automatically and uniformly, assuring conformity with the above listed international standards. The principle of the design is to allow the hammer to drop the required height into the soil in the mould which rotates circularly to distribute the blows uniformly over the surface of the specimen in the mould. The drop height is adjustable to 300 mm, 305 mm, 450 mm and 457 mm. The rammer is circular faced and interchangeable to 50 mm or 50.8 mm diameter. Rammer weight is adjustable to 2.5 kg or 4.5 kg according to reference standard. When compacting 100 mm diameter specimens the unit operates on a single radius and when compacting 150 mm diameter specimens the unit operates on inner and outer radius to obtain even compaction. The number of blows per layer can be set at the beginning of the test by the digital counter. This is important because the number of blows per layer have to be varied as necessary to prepare specimens having unit weights above and below the desired value. This automatic blow pattern ensures effective and equal compaction for each layer of soil by rotating the base table, so the mould, in equal steps and travelling the rammer across the mould. User defined blow number and in- out distribution is also available. Compactor is equipped with programmable digital counter which allows the machine: • To select reference standard (number of blows and mould size) by the operator at the beginning of the test • To set desired compaction cycle (number of blows and count of the number of inner and outer drops) by the user</p> <p>Supplied With The Automatic Soil Compactor is supplied complete with: • ASTM/EN/BS Rammer • ASTM Rammer Face, Ø 50.8 mm • EN/BS Rammer Face, Ø 50 mm</p> <p>Specifications Dimensions mm (W x D x H): 650 x 550 x 1550 Weight (approx.) Kg: 150 Power W: 370</p> <p>Modified Proctor Mould ASTM Description: Modified Proctor Mould Internal Dia. (mm): 152.4 ± 0.7 Body Height (mm): 116.4 ± 0.5 Volume (cm³): 2124 ± 25 Weight Kg: 9</p>	01

S. No.	Description	Qty
23	<p>ASTM Sieve Set: Complete Set (set of 10 sieves) ASTM Sieve Set Complete set Soil Sieve Set ASTM, 200mm dia, mesh sizes of 75mm, 50mm, 37.5mm, 25mm, 19mm, 9.5mm, 4.74mm, 2mm, 0.850mm, 0.425mm, 0.250mm, 0.106mm, 0.074mm with Pan and Cover</p>	02
24	<p>Planetary Mixer, Capacity 10 liter (Complete with bowl and beater) A robust device for the efficient mixing of asphalt mixes, this model is a table mounted unit with planetary mixing action and a bowl and whisk that are easily fitted and removed. The machine operates with a dedicated and easy to use display and keyboard interface.</p> <p>Either Standard speeds or user defined speeds can be easily selected (also adjustable during mixing). The front grill, when opened, automatically stops the machine for operator protection conforming to CE requirements. The machine is supplied complete with bowl and whisk. Power supply: 220 V 50 Hz 1 Ph 750 W ACCESSORY Isomantle heater with temperature regulator</p>	01
25	<p>Constant Head Permeability and Variable Head Permeability Apparatus</p> <p>Permeameter Stand for Constant and Falling Head Tests Comes With: - Proctor Permeability cell made in steel. Dimensions 0 4" (101,6 mm).(Qty 02) CBR Permeability Cell Made in Steel. Dimensions Ø 6" (152,4 mm). (Qty02) Permeameter Stand for Constant and Falling Head Tests</p> <p>BS 1377:5 – ASTM D2434 - AASHTO T215 - NF X 30-441 Formed by painted standpipe, with tubes, valves, connection tubes and adjustable height tank. The equipment can accommodate 4" (Proctor) and 6" (CBR) diameter cells, to be ordered separately. Dimensions: 1100 x 700 x 2200 mm. Weight: 90 kg Compaction Permeameters Used for determining permeability to water of soil gravel, clay, sand samples. Supplied complete with clamped upper and lower plate giving the possibility to perform permeability tests also on compacted samples, water inlet with valve, water outlet, two perforated upper and lower plates, two stainless steel screens. Steel made, plated against corrosion.</p>	01
26	<p>Miscellaneous Items Including Glassware and Tools etc. Trays various sizes (05 Qty) Scopes various sizes (10 Qty) Tool Kits (01 Qty)</p>	Lump Sum

S. No.	Description	Qty
	Glassware: Borosilicate Glass Beakers: 50ml, 100ml, 250ml 500ml 1000ml (05 Each Quantity) Volumetric Glass Flask: 50ml, 100ml, 250ml, 500ml, 1000ml (05 Each Quantity) Graduated Glass Measuring Cylinder: 50ml, 100ml, 250ml, 500ml, 1000ml (05 Each Qty)	

7) STRUCTURE/APPLIED MECHANICS LAB, CIVIL ENGINEERING DEPARTMENT Lot Wise Only – Both Import and Local Purchase allowed

S. No.	Description	Qty
1	<p>Roof Truss Apparatus</p> <p>For the study of strains, stresses, forces and deflections in various pin jointed frameworks, and the study of Bow's notation. Mounts on the Structures platform and connects to automatic data acquisition unit and software provided with the Structure Test Frame.</p> <p>Experiments: Introduction to Bow's Notation, Strain gauges as instruments, Forces and deflections in different frameworks, The Warren Truss, The Roof Truss (or Howe/Pratt Truss), Simple and advanced Cantilever Trusses, Force analysis by Method of Joints and Method of Sections, Deflection analysis by the strain-energy method, Wind loads on a roof truss, Effect of a swaying load on a cantilever truss, The principle of superposition for multiple loads (needs additional load cell)</p> <p>Specifications Pinned and roller supports, Additional Upright, Trammel Arm with Digital Indicator, Digital deflection indicator resolution 0.001mm, Three cables for computer display and data acquisition, Square-section steel Frame Members with strain gauges attached in full bridge configuration (4x strain gauges): 7 x long 205mm, 4 x medium 174mm, 2 x short 90mm, Member section 6mm square, 8 Joint Bosses, each connect members at 30, 45 or 60 degrees, Load Cell, Type-S of maximum capacity 650 N, Hexagon tools for fixing, inclinometer and storage tray included, Strain Gauge Amplifier, 16 input, Allows a number of frameworks to be built up, including a Warren Truss and a roof truss, Strain measurement: 16-way digital strain bridge, Gauge Type; 350 Ω type. Additional load cells, available to allow lateral forces to be applied, ie to simulate wind loading on roof trusses. Fits to the Structures Test Frame and HUB, Works with the data acquisition system, Works with the elab remote data acquisition system for remote teaching and learning</p>	1
2	<p>Wall Crane Apparatus</p> <p>Apparatus represents a planar central force system in which multiple forces act on a single point of application. Based on the example of a crane jib, forces are determined graphically and experimentally: resultant cable force, tensile force, compressive force. The directions and</p>	1

S. No.	Description	Qty
	magnitudes of the forces are determined graphically by way of a force parallelogram. A bar of adjustable length and a chain make up the crane jib, which is attached by adjustable clamp elements to a retaining bar. A variety of jib forms can be created. Loads are applied to the crane jib. The occurring bar forces are indicated by integrated spring balances.	
3	<p>Apparatus with all Accessories to</p> <ol style="list-style-type: none"> 1. Verify Law of Parallelogram of Forces 2. Verify Law of Polygon of Forces <p>Experiments: Concurrent and non-concurrent coplanar forces, An introduction to Bow's Notation and graphical analysis, Force triangles, polygons and Link polygons</p> <p>Specifications 15 metres of cord, 1x Ladder Model, 415 mm long, 19 rungs with 20 mm spacing, 1x Magnetic Hook Assembly, 2x Magnetic Protractors, 1x Spring Balance, 10 N range, 0.1 N increment scale, 5x Magnetic Pulley Assemblies, Weight Hangers – 5 off, 10 g each, Weights 250x 10 g, 8x Weight hooks, 2x Split Rings, Total Weight of parts = 3.9 kg + 1 kg storage tray, Work Panel / Frame</p>	1
4	<p>Circular Disc Apparatus</p> <p>Specifications Shows how to find the centre of gravity of shapes and the relationship between angles and coplanar forces. Experiments includes Centres of gravity, Force triangles, Force polygons and Bow's Notation, Linked polygons (non-concurrent forces), Main parts includes: 6x Plastic shapes (two-dimensional), Marker pen, 5x Pulley assemblies, Weight hangers and weights, Cord and rings, Magnetic protractor, Work Panels/Frame</p>	1
5	<p>Apparatus to Determine Reaction of Beam</p> <p>For the study of wide variety of beam experiments, from simple cases to complex problems. Mounts on the Structures test frame and connects to the automatic data acquisition unit and software provided with the Structure Test Frame.</p> <p>Experiments: Principle of moments, Reactions for a point load along a simply supported beam, Reactions for a uniformly distributed load (UDL) on a simply supported beam, The principle of superposition, Influence Lines, Deflection of a simply supported beam, Reactions for a continuous beam, Reactions and moments of a propped cantilever, Reactions and moments of a fixed beam, The effect of a sinking support</p> <p>Specifications Two simple supports measuring vertical reaction, A universal support that measures vertical reactions and can act as a fixed or sinking support, A moment support measuring fixing moment, A rigid plated Mild Steel beam of length 850 mm and 19 x 6.3 mm section, A flexible Aluminium beam of length 600 mm and 18 x 2 mm section, Nine Mass Hangers and 50 x 20 g masses, Hexagon tools, Steel Rule, Vernier Caliper and Storage Tray included, A digital indicator mounted on a traversing mechanism for</p>	1

S. No.	Description	Qty
	<p>measuring deflections, and a mechanism which measures beam end fixing moments, There are to be three load cell piers to measure vertical beam reactions. One of the load cells are to have variable height knife-edge to allow for sinking supports., Each pier features an integral load cell amplifier, which connects to the Hub.Force measurement using load cells with Rated capacity: 3kg, Rated output: 2.0 mV/V, Rate output tolerance: +/- 0.2 mV/V Zero return, 30min +/- 0.05 % of applied load, Total error +/- 0.03 % of rated output Temp range compensated -10 to +40 deg C</p>	
6	<p>Apparatus (with all accessories) for Determining Coefficients of friction for Various Materials</p> <p>Shows the frictional and other forces on bodies and between different surfaces on a flat or inclined plane. Experiments: Forces on an Inclined Plane, Rolling and Sliding Friction on different surfaces, Kinetic and Static Sliding Friction between different surfaces, Surface angle and friction between different surfaces, Main parts includes: Inclunable plane, Car or sled, Friction Plates – Wood, Plastic, Steel, Friction Surfaces – Wood, Plastic, Rubber, 2x Weight hangers and 100x 10 g weights, 20x 1 g weights, Roller Set, Work Panels/ Frame</p>	1
7	<p>Torsion Testing Apparatus 30 Nm to 50Nm</p> <p>Includes: Torsiometer, Data Acquisition System Bench Top Interface Unit and Software, Torsion Specimen Steel as drawn (Qty 10), Torsion Specimen Steel Normalised (Qty 10), Torsion Specimen 0.4% as Drawn (Qty 10), Torsion Specimen 0.4% Normalised (Qty 10), Torsion Specimen Half-Hard Brass (Qty 10), Torsion Specimen Grey Cast Iron (Qty 10)</p> <p>Experiments: Determination of modulus of rigidity (shear modulus) and yield strength, Determination of upper and lower yield stresses for normalised steel specimens, Reversed torsion tests to demonstrate the Bauschinger effect and the effects of residual body and textural stresses on torsional strength, Comparison of the different elastic and plastic properties of materials</p> <p>Specifications</p> <ul style="list-style-type: none"> • To include a Gearbox Strain Head and a Torque Measurement Head, mounted on a precision engineered sturdy box-section alloy base with adjustable feet • Gearbox to be a 60:1 ratio sealed gear and worm drive unit, capable of being moved and locked to any point along the frame • Torque to be applied by turning the handle of the gearbox • The Torque Measurement Head to have a moment arm and an industrial force sensor (strain-gauged load cell) • The torque shaft to be supported by bearings • The load cell must be able to connect to suitable data acquisition system • Maximum Torque 30 Nm • Angular Strain Measurement to be via Electronic Encoder and Digital Display 	1

S. No.	Description	Qty
	<ul style="list-style-type: none"> • A clear removable guard to cover the specimen area for safety • To include a 12 V DC Digital Load Meter, range 30 Nm, and a 12 V DC Digital Angle Meter, range greater than 10,000 degrees • The Digital Angle Meter to display down to 0.01 degrees, the Angle to be displayed in radians with a resolution of 0.0001 • Maximum specimen length: 750 mm • To be supplied with 2 sets of Drive Sockets – 3/16” Whitworth and 12 mm AF hexagonal (Qty 2 each) • Includes a set of ten 0.15% Carbon Steel specimens, 230M07 as drawn: nominally 143 mm total length, with 76.2 mm long gauge length, 6 mm diameter test section. Specimens ends to be nominally 12 mm across flats • includes a set of five 0.4% Carbon Steel specimens, 212A42, two grooves as drawn: nominally 143 mm total length, with 76.2 mm long gauge length, 6 mm diameter test section. Specimens ends to be nominally 12 mm across flats • includes a set of five half-hard Brass, 60% copper, 40% zinc specimens, CZ121 as drawn: nominally 143 mm total length, with 76.2 mm long gauge length, 6 mm diameter test section. Specimens ends to be nominally 12 mm across flats • To be compatible with Data Acquisition System Torsiometer • 50 mm gauge length • 6 mm nominal specimen clamp diameter • Inches or Millimetres (0.001 Inches = 0.001 radians) 	
8	<p>Shear Centre and Unsymmetrical Bending Cantilever Apparatus</p> <p>For the study of the vertical and horizontal deflection of different unsymmetrical sections. Mounts on the Structures platform and connects to the automatic data acquisition unit and software provided with the Structure Test Frame.</p> <p>Experiments: Show that shear centre can be outside beam section boundaries, Shear centre of an unsymmetrical section, Horizontal and vertical deflection in symmetrical and unsymmetrical sections at different loads and load angles, Using Mohr’s circle to find Principal Axes and Second Moments of Area</p> <p>Specifications: Three test beams of different cross-sectional shape: Rectangle, Square Angle (L), Channel (U) Section, A plate holding two Deflection Indicators, each of resolution 0.01 mm, Includes two mass hangers and 25 x 20 g masses, Two different study areas in one product: shear centre and bending, Vernier caliper, Hexagon Tools for assembly and Storage Tray included, Consisting of a left hand plate and chuck, designed to index in 22.5° steps (giving 16 angular increments), Right hand plate to have two digital indicators able to be arranged at 90° to each other for the unsymmetrical bending experiment or parallel to each other for the shear centre experiment</p>	1
9	<p>Apparatus to Investigate the Stresses and Strains within Structures in Relation to Bending Loads with Accessories Data Acquisition System and Software</p>	1

S. No.	Description	Qty
	<p>For the study of determinate and indeterminate truss structures. Mounts on the Structures platform and connects to the automatic data acquisition unit and software provided with the Structure Test Frame.</p> <p>Experiments: Strain Gauges as instruments, Forces within and deflections of: A truss structure that is statically determinate, A truss structure that is statically indeterminate, Member forces by the Method of Joints and Method of Sections, Member forces by the use of the strain-energy method, Advantages and disadvantages of both versions of the truss</p> <p>Specifications: Simple thumbscrew adjustment for easy engagement of the redundant member. Strain Gauge Amplifier, 16 input, for measurement of force in each member of the truss. Load Cell, S-type electronic, of maximum capacity 650 N, Pre-assembled truss of five joint bosses and eight square-section members, Inclinator, Hexagon tools for fixings and Storage Tray included, Trusses to be made of stainless steel, with mechanical joint pieces/bosses, effective truss length to be 230mm. Two of the trusses are specially designed so that one of the trusses can act as the redundant truss and can be added to, or taken out of, the structure by means of an adjustable thumbwheel, the other special truss to be fitted with a central ring that the redundant truss can pass through it. The central ring is to provide the same extension per unit force as the rod itself. Each truss member to have full bridge (ie 4 off) strain gauges attached, comprising 2 longitudinal (to relieve the effect of bending) and 2 transverse gauges (to negate temperature effect). Strain gauge type 90° Rosette, Strain gauge resistance 350 ohm $\pm 0.2\%$, The strain gauges connect to a digital strain bridge, capable of taking up to 16 inputs, and containing an Automatic Data Acquisition socket to allow datalogging on a PC</p>	
11	<p>Portal Frame Apparatus</p> <p>For the study of bending moments and sway in portal frames. Mounts on the Structures platform and connects to the automatic data acquisition unit and software provided with the Structure Test Frame.</p> <p>Experiments: Strain gauges as instruments, Relationship between measured strain and bending moment, Elastic bending of portal frames, and linear relationship between the bending moments in the frame and the load, Use of the Moment Distribution (Hardy Cross) Method to calculate bending moments, sway magnitude and horizontal support reactions, The generation and measurement of sway deflections and bending moments around the frame due to: Vertical loads on the beam, Horizontal loads at the junction of the beam and uprights, Moments applied to the uprights, Any combination of the above, Plotting of bending moment diagrams</p>	1

S. No.	Description	Qty
	<p>Specifications: Backplate holding the Portal Frame of 250 mm x 495 mm (section centre distances). Nominal cross section: 19 x 3.2 mm. 16 strain gauges attached to portal. Strain Gauge Amplifier, 16 input, A digital indicator to measure horizontal deflection (sway) at the corner of the of the portal frame, Hexagon tool for fixings, Vernier Caliper, Four Mass Hangers, 50 x 20 g Masses and Storage Tray included, The portal is to be composed of three members of aluminium flat bar, consisting of a horizontal beam and two vertical members joined at two upper corners, and clamped to the bottom of the back panel to form a symmetrical frame, Each member to have the same flexural rigidity (IE) value, The back panel to the nominal dimensions of the frame, and the dimensions and positions of the strain gauges and loading positions around the frame, The portal is to have sixteen strain gauges – eight along its horizontal member and four along each vertical member. The gauges to connect to a 16-channel digital strain hub, Strain gauge, linear pattern, resistance 350 ohm $\pm 0.6\%$, Horizontal loads are to be applied via a loaded cable carried over pulley, and connected to a hook in the corner or of the frame, The portal frame is to have 3 x fixed loading joints on the horizontal member, Portal Frame: Aluminium 500 mm x 250 mm, nominal member dimensions 19 mm x 3.2 mm, To include two moment arms which can be fixed to the vertical members to simulate the effect of an internal or external balcony, or an internal floor.</p>	
12	<p>Suspension Bridge App with Accessories</p> <p>For the study of the characteristics of a simple suspension bridge. Mounts on the Structures platform and connects to the automatic data acquisition unit and software provided with the Structure Test Frame.</p> <p>Experiments: How bridge load affects the tension in a suspension cable, comparing a central point load with a UDL, Exploring the ratio of bridge 'deck' mass and a moving load, comparing simple parabola-based theory with a more realistic analysis of the model</p> <p>Specifications: Two bridge supports, Cable suspension bridge and deck. 0.5 m span and 0.1 m sag, Nine Mass Hangers, 50 x 20 g Masses, Hexagon tool for assembly and Storage Tray included, To consist of a "stiff" loading deck held by fixed length vertical hangers and a suspension cable, The hangers to clamp to the cable and deck at regular spacings, giving a uniformly spaced suspension bridge, The suspension cable passes over pulleys at the top of each support. The right hand support clamps the end of the cable, the left hand support uses a load cell to hold the end of the cable, to directly measure the cable tension, Integral load cell amplifier.</p>	1
13	<p>Three Hinged Arch App</p> <p>For the study of the characteristics of a three-pinned arch under various load conditions. Mounts on the Structures platform and connects to the automatic data acquisition unit and software provided with the Structure Test Frame.</p> <p>Experiments: Horizontal reaction due to a varying single point load on a statically determinate structure, Horizontal reaction due to a moving single</p>	1

S. No.	Description	Qty
	<p>point load on a statically determinate structure, Horizontal reactions due to a uniformly distributed load on a statically determinate structure, Influence lines and superposition, Lines of thrust in an arch, Graphical construction of a bending moment diagram for point loads, Maximum bending moments due to a load on an arch</p> <p>Specifications: Two arch supports, holding an arch of 0.5 m span x 0.1 m height, Nine evenly spaced hanging points, Nine Mass Hangers, 50 x 20 g masses, storage tray included , To consist of two supports and two symmetrical bridge halves joined by a pin at the crown. The left-hand half is permanently pinned to its support (the pin allowing rotational movement only). The right-hand side can rotate and slide up to an electronic load cell. The load cell reacts and thus measures the horizontal reaction produced by the arch. Arch:xxx mm rise, xxx mm span, 9 loading positions, Integral load cell amplifier.</p>	
14	<p>Bending Moment and Shearing Force Apparatus</p> <p>For the study of the basic theory of bending moments in a beam. Mounts on the Structures platforms and connects to the automatic data acquisition units and software provided with the Structure Test Frames.</p> <p>Experiments: Bending moment at the cut due to a varying single point load. Bending moment at the cut due to a moving single point load. Bending moment at the cut due to a uniformly distributed load. Influence lines and superposition. Shear force at the cut due to a varying single point load, Shear force at the cut due to a moving single point load, Shear force at the cut due to a uniformly distributed load, Influence lines and superposition.</p> <p>Specifications: Module I: To consist of a beam which is 'cut' by a pivot and supported by a moment arm acting on an electronic load cell to measure applied force. Beam to have 14 loading positions at 50mm intervals, Additional to the 14 loading positions 2 off Uniformly Distributed Load masses. 360 grams x 250mm long each. Moment Arm to be 800 mm long and 500 mm span, Pivots and mechanisms to be fitted with ball race bearings, allowing rotational movement, One of the supports also allows for horizontal movement Integral load cell amplifier, zeroed using the software.</p> <p>Module II: Two supports, holding a beam of 0.8 m length and 0.5 m span, Shear force load cell built into the centre span of the beam, Direct reading of shear force at the 'cut' for quick and simple experiments, Four Mass Hangers, 50 x 20 g masses, Two UDL bars and Storage Tray included To consist of a beam which is 'cut' by a pivot and supported by a mechanism acting on an electronic load cell to measure the shear force. Beam to have 14 loading positions at 50mm intervals Pivots and mechanisms to be fitted with ball race bearings, allowing rotational movement.</p>	1
15	<p>Portal Frame Apparatus</p> <p>For the study of plastic theory and limit state design in portal frames. Mounts on the Structures platform and connects to the automatic data acquisition unit and software provided with the Structure Test Frame</p>	1

S. No.	Description	Qty
	<p>Experiments: Elastic bending to plastic deformation of portal frames, Collapse load and the formation of plastic 'hinges' Yield stress, Deformation due to single and combined loads on a portal frame, Generating an Interaction Diagram, Shape of a collapsed portal due to hinge formation, Introduction to Limit State Design Shape or Form Factor and the additional factor of safety it provides.</p> <p>Specifications: Main frame with portal fixing blocks and two deformation indicators of resolution 0.01 mm set to measure horizontal and vertical deformation, Vertical and horizontal S-type load cells, maximum capacity 650 N, The electronic load cells load the specimen frame by wires and adjustable pulleys, to ensure that the frame is pulled in the correct direction, Nine specimen portals of experiment size 200 mm height and 300 length Nominal cross section: 3.2 x 12.7 mm, Hexagon tools for fixings, Vernier Caliper and Storage Tray included To consist of a specimen steel portal frame held firmly at the bottom corners by two fixing blocks.</p>	