Summary of Specifications

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Note: The delivery of all items will be at NTU Karachi campus.

Initial Specifications

Item # 1	**Sample Warping Machine (Pilot Scale)**
•	Yarn materials: Cotton, Polyester Cotton, Kevlar, Carbon, Glass, Jute or similar
•	Nominal Working Width: 850 mm or higher
•	Drum Circumference: 2000 mm or more
•	Speed: 350 m/min or higher
•	Stop motion
•	Maximum number of threads: 5200 or higher
•	Warping beam length range: 3 meters (min.) – 7 meters (max)
•	Automatic Colour Selectors: 4
•	Touch Screen Panel
•	Integrated Beaming Unit
•	Stationary Creel: 4 or more accumulators
•	Number of weaver beams: 4 or more
Stationary hook system for better grip of synthetic yarn	
Warping with ring technology	
Equipped with 5 leasing rods and 2 leases	
Setup for knotting	
•	Power back up for emergency shut down in safe mode
•	Real time data acquisition / analysis system (fixed)
•	All parts / accessories required to make machine operational on site
•	List of similar installed machines in universities/industry in Pakistan and worldwide with their contact information
•	List of trained engineers available for after sale service/maintenance
•	Additional Points:

Initial Specifications

Item # 2	**Single-end Sizing Machine**
•	Yarn materials: Cotton, Polyester Cotton, Kevlar, Carbon, Glass, Jute or similar
•	Sizing materials: PVA, Starch, Wax etc.
•	Number of packages to be sized at a time: 1 or more
•	Speed: 190 m / min or higher
•	Sizing temperature range: 90-100 °C
•	Length measuring sensor
•	Electrical-heating in sizing tank
•	Hot air drying
•	Yarn break sensor
•	Power back up for emergency shut down in safe mode
•	Real time data acquisition / analysis system (fixed)
•	All parts / accessories required to make machine operational on site
•	List of similar installed machines in universities/industry in Pakistan and worldwide with their contact information
•	List of trained engineers available for after sale service/maintenance

Initial Specifications

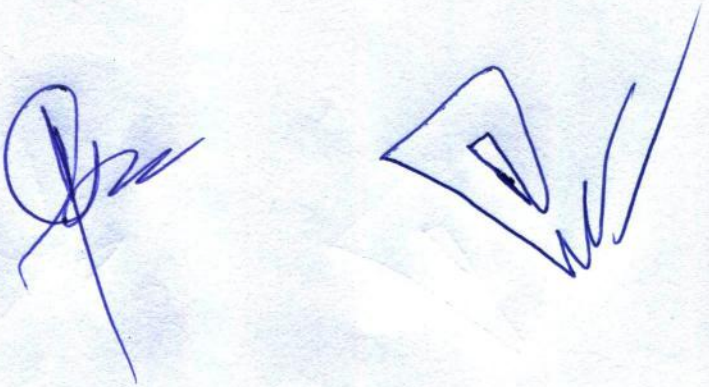
Item# 3	Sample Rapier Loom (Pilot Scale)
•	Yarn materials: Cotton, Polyester Cotton, Kevlar, Carbon, Glass, Jute or similar
•	Working width: 500 mm or more
•	Number of frames: 22 or higher
•	Shedding system: Dobby (electronic)
•	Speed of machine:70 PPM or higher
•	Weft stop motion
•	Electronic let off and take up
•	Weft insertion: Rigid Rapier
•	Weft Color Selectors: Electronic Controlled (4)
•	All parts / accessories required to make machine operational on site
o	Additional accessories:
o	Frames up to 24 frames
2-	Frame motion is pneumatic shedding

Initial Specifications

Item# 4	Semi Automatic Sample Loom
Number of frames:	16 or higher
Shedding system:	Dobby
Pneumatic lifting/lower of frames	
Mannual picking and beating up	
Warping beam capacity: 3 metres or higher	

Initial Specifications

Item # 5	Air Compressor
Upto 20 HP=15KW (with regulated speed control) Rotary Screw Compressor , Stainless steel Components, Reliable through integarted design with oil sepration, oil filter and thermostatic bypass. reduced CO_2 emission, easy removal of pnaels and covers	
Oil free Air:	Meets the 1SO air specific standards for processes within the textile industry textile, and electronics industries
Noise Level :	Meets the minimum noise level requirements
Ambient operation:	Withstand 40-50 ºC maximum ambient temperature
Mendatory accessories:	air and oil filters, Pressure regulators,



Initial Specifications

Item# 6	Lab-Scale Jigger Dyeing Machine
Description	A sample jigger for dyeing up to 20 meters of fabric at atmospheric conditions.
Width	Min. 20 inches
Fabric speed	Variable Speed Control
Fabric tension	Adjustable
Temperature range	Room temperature to 95 C or above
Heating	Electrical heating with rate of rise and top temperature control

Initial Specifications

Item# 7	Lab-Scale Winch Dyeing Machine
Winch real Speed :	35-50 r.p.m. at 50 Hz or Variable Speed Control
Door:	Two doors, one each at front end back
Guids roller:	Detachable type with 3 guide bars
Heat Soruces:	Internal heating system
Material:	Stainless steel
Goods to be handled:	Woven and knit goods of various kind
Processing capacity: Weaight:	Min. 3 Kg or above
Max-working Temperature:	98 C and higher
Vapor pressure:	3-5 Kg/cm2 or higher

Initial Specifications

Item# 8	Lab-Scale Softflow Dyeing Machine
Goods to be handled:	Woven and knit goods of various kind
Processing capacity: Weaight:	Min. 1 Kg or above
Cloth Speed:	Variable Speed Control
Liquir Volume:	10 - 60 Liters or higher
Max-working Temperature:	130 C or higher
Material of Machine:	Stainless steel
Heating/ Cooling	Heating at Below 0.5 to above 4 °C/min and cooling below 3 °C/min
Liquor preparation bath	Min. 10 L
Liquor preparation bath	Min. 10 L

Initial Specifications

Item# 9	**Lab-Scale Pad Steam Dyeing Machine**
Pickup range	60% to 100%
Fabric speed	Variable Speed Control
Dwell time in steamer	Dwell time Min. 20 Sec or lower - Max. 90 seconds or higher
Padder	Pneumatically-Controlled, Maximum pressure 1-6kg/cm or above, NBR rubber with 70o Shore
Steaming chamber	Insulated, Max. Temperature Max 100°C or higher., Pressure 0.5mPa or above
Display	Digital display temperature indicator
Steam Generation	External Steam Generator Included
Display	Digital display of parameters
Width	Min 500 mm or above
Washing compartments	Min. 4, with direct steam heating and temperature regulator
Fabric take up/ batching system	included
Parts to be included: IR pre dryer, Steaming chamber, Steam generator	

Initial Specifications

Item# 10	Lab-Scale Pad Thermosole Dyeing Machine
Fabric speed	Variable Speed Control
Padder	NBR rubber with 70o shore, 0.1 ~ 0.5mPa, 2 pressure gauges, Total trough capacity 500ml, vapour-pressure type
Width	Min. 500 mm
Maximum Temperature	250°C or above
Infrared heating system	Min. 12 reflect-type IR heaters, Heating distance 800 - 900mm or above,Fabric distance 70-120 mm (adjustable)
Thermosoling	1500mm or above, 250°C or above, Precision ± 1%.
Dryer	Drying distance 1800mm or above, Temperature 100 ~ 180°C,
Fabric take up/ batching system included	
Circulation air speed	Min 4 m/s or lower – Max. 15 m/s or higher
Circulation air capacity	800 – 3000 m^3/h or higher

Initial Specifications

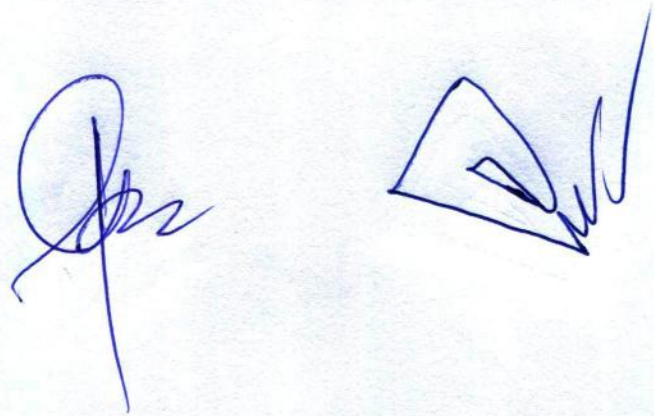
Item# 11	Lab-Scale Rotary Printing Machine
Speed:	Min. 10 m/min or Higher
Screen Repeats:	Min. 500 mm
Screen type:	Rotary and Blade/Rubber
Min. Sample size	Min. 60x128 cms or higher
Can be used for flat bed printing	
Squeegee	Rod type, Blade type
Electromagnet strength	1-100%
Bed type	Flat

Initial Specifications

Item# 12	Lab-Scale Digital Printing Machine
Printing width:	Min. 600 mm
Media Width:	Min. 500 mm
Number of Ink Channels/Colors	4-8
Inksystem type :	1-2 litre
Take Reel:	Yes
Maximum Print Resolution:	Min. 720-1440 DPT

Initial Specifications

Item # 13	IR Dyeing Machine
Temperature range: 40-135 °C or higher, accuracy +/-1°C, gradient at 3°C/min up to 135°C	
Heating or cooling speed: 0.5 – 3.5 °C / min	
Temp. Control accuracy: 0.5 °C-1°C	
Rotation speed: 10– 50 rpm (adjustable)	
Dyeing Beaker : 180-200ml, 450-500 ml, 1000-1200ml	

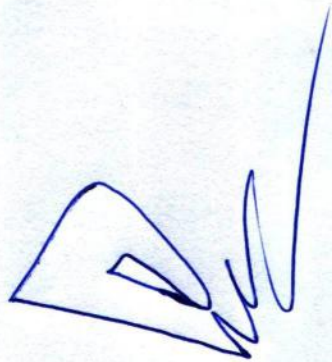


Initial Specifications

Item # 14		Color Spectrophotometer
S.N.	**Characteristic**	**Tender Specifications**
1	Instrument Type	d/8° spectrophotometer
	Spectral Analyser	Dual Beam analyser
		Able to work between 360-700 nm
	Reflectance	Yes
	Tranmittance	Yes
	Measuring resolution	2 nm
	Spectral Interval	10 nm
	Illumination Source	Pulse Xenon filtered to D65
	Sphere Diameter	Minimum 150 nm
	Photometric Range	0-200 %
	Inter-instrument agreement CIE ΔE	0.08
2	UV cutoff Filters	400 nm, 420 nm, 460 nm
3	Reflactance Apertures	26mm, 16 mm, 5 mm, 2.5 mm
4	Transmission Apertures	22 mm
5	Sample Positioning	Adjustable with camera
6	Display	Builtin Color LCD Display
7	Lens	Auto Zoomable
8	Softwares	Color Measurement
		Prediction/Matching Database
9	Data Acquisition System	Compatible with equipment + All softwares pre-installed & upgradable
12	Accessories	All accessories to make and keep the unit operational

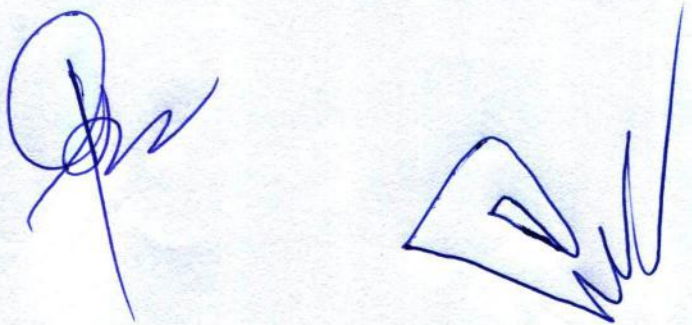
Initial Specifications

Item # 15	High Volume Instrument
1	Can test the length, strength, fineness, color and moisture, color characteristics and trash particle content in cotton
2	Able to determine fineness and maturity properties of fiber
3	Determine fiber length and tensile properties
4	Automatic Color Tray or increased sampling for higher throughput
5	Dual Sampler for increased sampling for higher throughput
6	Data acquistion system
7	Must include Standard Calibration Materials
8	Micronaire Measured by relating airflow resistance
9	Maturity, Calculated using algorithm
10	Length, Upper Half Mean Length, Uniformity Index, Short Fiber Index Measured optically in a tapered fiber beard which is automatically prepared,
11	Strength and elongation, measured physically by clamping a fiber bundle between 2 pairs of clamps at known distance
12	Moisture content, using conductive moisture probe
13	Color, Rd (Whiteness), +b (Yellowness), color grade, measured optically by different color
14	Trash, Particle count, % surface area covered by trash, measured optically by utilizing a digital camera
15	Calculation of spinnability of cotton



Initial Specifications

Item# 16	Yarn Evenness Tester
1	Determination of trash and dust particles in the yarn
2	Determination of the diameter, roundness, density and the surface structure of the yarn
3	Determination of the yarn hairiness
4	Measuring unit for heavy sliver, wool tops in the range 12–80 ktex
5	Determination of the unevenness and imperfections (thin and thick places plus neps)
6	Determination of foreign matter
7	Measurement of humidity and temperature in the environment of the test unit



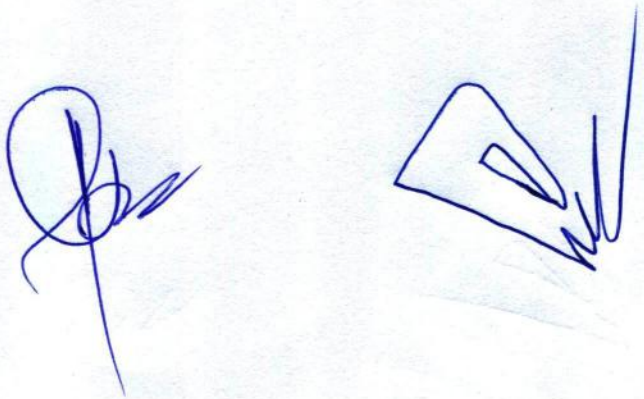
Initial Specifications

Item # 17 **Fabric Crease recovery tester**

1	Operation	Standard fabric crease recovery tester in two versions for applying different loads (10N and 19.63N weights) to meet the requirements of European and American standards
		Must Include
		European Standards (EN, ISO and M&S)
		Loading Device (10N and 19.63N weights)
		Specimen Tweezers (Metal)
		Specimen Tweezers (Plastic)
		Specimen Template 40 x 15mm
		Specimen Template 50 x 25mm
		Pack (25 sheets 100 x 150mm) Paper Tissue
		American Standards (AATCC)
		Loading Device (500g weight)
		Specimen Tweezers (Metal)
		Specimen Tweezers (Plastic)
		Specimen Template 40 x 15mm
		Specimen Template 50 x 25mm
		Pack (25 sheets 100 x 150mm) Paper Tissue

Initial Specifications

Item# 18	Fabric Hydrostatic Head Tester
1	Internal water reservoir
2	Maximum pressure 3 bar
3	10 cm^2, 19.63 cm^2, 26 cm^2 , 28 cm^2, 100 cm^2 test head and Pore Size Attachment included
4	Fulfills AATCC 127 BS 3321 ERT 120-1 ISO 811 AFNOR G07-057 BS EN 20811 ERT 160-0 ISO 9073-16 JIS1092 B-b ASTM D751 EN 343 GB/T 4744 IST 080.4 (01) IST 080.6 (01) WSP 080.6.R4 (12)
5	Securely holds samples of up to 30 mm thick



Initial Specifications

Item#19		Light Fastness Tester
1	Lamp	Xenon arc lamp according to ISO, AATCC and EN standards
2	Reference lamp	Calibrated xenon reference lamp
3	Cooling system	Water / Air cooled
4	Exposure area	Minimum 2100 cm^2
5	Irradiance Monitoring System	Efficient radiometer for irradiance monitor
6	Irradiance (300-400nm) Range	Setting and control of irradiance for 340nm, 420nm, 300-400nm or Lux
7	Custom xenon spectrum	Should be equipped with interchangeable glass filters to adjust xenon light spectrum as per requirments
8	Test Chamber Humidity Range	Setting and control of relative humidity (Ambient – 95% RH) with efficient system
9	Test Chamber Temperature Range	Ambient – upto 60 °C Setting and control of air temperature
10	Sample capacity	Should be able to expose 60 samples at a time
11	Black Standard Temperature Range	Ambient – upto 70 °C. Setting and control of Black Panel Temperature; uninsulated (BPT) or insulated (BST)
12	Water Reservoir Capacity	30 liters
13	Water Consumption (ISO 105-BO2 Normal)	0.9 L/hr
14	Air and water purity	Dust filters for intake air Water purity indicator
15	Variation reduction system	Should have a dedicated system for reduction in variation of chamber temperature and humidity
16	Software and Display	Touch display control panel (minimum 12") with control of all test parameters Pre-programmed test methods for ISO, AATCC and other common standards Possibility for developing custom methods Auto fault detection and display of diagnostics on touch display
17		AATCC 16 AATCC 169 ASTM C1442 ASTM D2565 ASTM D3424 ASTM D4303 ASTM D4355 ASTM D4459 ASTM D4798 ASTM D5071 ASTM D6551 ASTM D6695 ASTM D904 ASTM E1596 ASTM G151 ASTM G155 FLTM BI 160-01 GME 60292 GMW 14162 GMW 3414 ISO 105-B02 ISO 105-B04 ISO 105-B06 ISO 105-B10 ISO 12040 ISO 16474-2 ISO 3917 ISO 4892-1 ISO 4892-2, JASO M346 MIL-STD 810F MIL-STD 810G PV 1303 PV 3929 SAE J2412 SAE J2527 VDA 621-429 VDA 621-430 VDA 75202 VW PV 3930
18	Compulsory Accessories	All sample holders for complete frame to meet above test standards Water purification system
19	Safety standards	Must meet UL, CE, ISO, EN and CSA safety and electrical standards
20	Reference	Reference of labs currently using the instrument in Pakistan (Prefeably in Faisalabad)

Initial Specifications

Item# 20		Flameability tester
1	Switch	Marker thread switch
2	Test frames	interchangeable test frame with frame stubs and pins
3	Finishing	heat resistant finish
4	Ignition	automatic ignition
5	Controls	burner to specimen adjustor
		gas flow regulator
		burner setting guages
6	Data extraction	test report exportation
7	Standards	EN ISO 6940
		EN ISO 6941
		EN ISO 15025
		EN 1101,1102
		EN 71-2
		EN 13772
		EN 13722
		EN 1624
		EN 1103
		EN 14878
		EN 1625
		BS EN 532
		BS 7837,5722, 5867-2, 6249
8	Gas burners	range of gas burners as accessories to comply with all standards

Initial Specifications

Item# 21	Digital pH Meter
Range:	0.0 to 14.0 pH
Accuracy:	+/0.1pH
Probe:	pH electrode
Display:	Seven segment Display
Relative Humidity:	5 to 90 % non-condensing

Initial Specifications

Item# 22	Digital Viscometer
Rotation speed	0.3 and 250 rpm
Conformance with Standards	ASTM / DIN ISO 2555 / ISO 3219 oder MS-R Standards
Torque Range	From 0.05 to 13 mNm and From 0.005 to 0.8 mNm
Temperature	-50 °C to + 300 °C.
Accuracy	+/- 1 %
Repeatability	+/- 0.2 %
Measuring Capacity (ml)	3-100 ml
Viscosity Range	3 - 180,000,000 mPa·s
Display Option	Viscosity – Speed – Torque – Temperature - Time – Measuring geometry, Level of sensitivity – Date/hour - Choice of viscosity units: cP or mPa·s Language. French/English

Initial Specifications

Item# 23	Time Constant Calculation Apparatus
1	To be used for the calculation of time constant of mercury (glass-bulb) thermometer. It uses heating mantle, round bottom flask, oil/water, thermocouples, glass bulb thermometers, temperature controller etc.
2	Water Bath:Ice Flask, Hot water tank with Heat Plate, Thermocouples & Temperature Sensors, K Type, J Type, RTD (PT-100)
3	Control Panel & Software designed in LABVIEW environment to run under any Window platform
4	220V/AC, 50 Hz
5	Data acquisition system

Initial Specifications

Item# 24	Pressure Gauges Calibration Apparatus
1	To be used as a calibration apparatus which is used for the calibration of bourdon pressure gauges. It is equipped with PID controller, compressor, needle valve, solenoid valves, safety valve, digital/master gauge, bourdon pressure gauges, transducer, storage tank etc. It uses air as a gas whose pressure is controlled at any specific desired value and the gauges are accordingly calibrated.
2	Measuring devices for pressure and vacuum
3	U-tube and inclined tube manometers
4	Bourdon tube manometer, pressure above atmospheric
5	Bourdon tube manometer, pressure below atmospheric
6	Plastic syringe generates test pressures in the millibar range
7	Bourdon tube manometer: 0...60mbar
8	U-tube manometer: 0...500mmWC
9	Inclined tube manometer: 0...500mmWC
10	Pressure Transmitter with Digital Display: 0 to 4 bar
11	Calibration Gauge: 0 to 4 bar
12	Calibration Source: Pressure Pump Hand Operated with Built in Safety
13	Pressure Control: Regulator with Valve
14	Data Acquisition Unit
15	PC Interface Software

Initial Specifications

tem# 25	Temperature process station
1	To be used to control temperature. It is fitted with PID controller, pumps, valves, heaters, bi-metallic gauge, k-type thermocouples, service tank, process tank, stirrer, radiator etc. It uses water as a liquid whose temperature is controlled at any specific desired value inside the process tank.
2	Fixed Supply DC: +12V, +15V, -15V & +24V
3	Process Vessel: 5 Liter approx.
4	Storage tank: 20 Liter approx.
5	Heater Element: 200W
6	Water Circulation Pump: 10 l/min
7	Piping: PVC
8	Thermal Sensors: K-Type Thermocouple, PT100, Bi-metallic Direct Reading
9	Valves: Drain Valve Manual Type
10	Level Sensor: Float Switch with LED indicator
11	Flow Sensor: Rotameter Direct Reading Type
12	Cooling Temperature Controller: Auto Control with PID
13	Cooling Apparatus: Heat Exchanger with Fan
14	Operation Mode: Internal & External
15	Temperature Sensor Interface: DC Amplifier with Offset and Gain Control
16	ON/OFF Control: Comparator with Hysteresis Control
17	Analog Source: 0 ~ ±10V
18	PID Controller: Proportional, Integral & Differential Control with Feedback
19	Pump Driver: DC to PWM Driver with DC Level Offset Control
20	Heater Driver: DC to PWM Driver with DC Level Offset Control
21	Accessories: Power Cord, 2mm Patch Cord, Experiment Manual,
22	Data Acquisition Unit
23	PC Interface Software

Initial Specifications

Item# 26	Pressure process station
1	Used to control pressure. It is fitted with PID controller, compressor, needle valve, motorized valve, solenoid valves, safety valve, bourdon pressure gauges, transducer, storage tank, process tank etc. It uses air as a gas whose pressure is controlled at any specific desired value inside the process tank.
2	Fixed Supply DC: +12V, +15V, -15V & +24V
3	Vessel: 5 Liter approx.
4	Piping: Plastic
5	Pressure Sensor: Manometer Direct Reading, Strain Gauge
6	Valves: Manual, Solenoid, Motorized valve, No Return, Safety set at 2.0 Bar
7	Pump: 35psi
8	Pressure Sensor Interface: Differential Amplifier with Offset and Gain Control
9	ON/OFF Control: Comparator with Hysteresis Control
10	Analog Source: 0 ~ +10V, 0 ~ ±10V
11	PID Controller: Proportional, Integral & Differential Control with Feedback
12	Pump Driver: DC to PWM Driver with DC Level Offset Control
13	Solenoid Valve Driver: ON/OF Control with Driver Manual & auto
14	Accessories: Power Cord, 2mm Patch Cord, Experiment Manual,
15	Data Acquisition Unit
16	PC Interface Software

Initial Specifications

Item# 27	Level Process Station
1	Used to control of liquid level. It is fitted with PID controller, pump, valves, variable-area flow meter, DP transmitter, feed tank, process tank etc. It uses water as a liquid whose level is controlled at any specific desired value inside the process tank.
2	Fixed Supply DC: +12V, +15V & +24V
3	Vessel: Dual 5 Liter approx.
4	Water Circulation Pump: 10 l/min
5	Piping: Plastic
6	Level Sensor: LVDT, Float Switch
7	Flow Sensor: Direct Reading
8	Valves: Drain, Solenoid, Needle
9	Level Sensor Interface: Precision Rectifier with Offset and Gain Control
10	ON/OFF Control: Comparator with Hysteresis Control
11	Analog Source: 0 ~ ±10V
12	PID Controller: Proportional, Integral & Differential Control with Feedback
13	Pump Driver: DC to PWM Driver with DC Level Offset Control
14	Solenoid Valve Driver: ON/OF Control with Driver
15	Accessories: Power Cord, 2mm Patch Cord, Experiment Manual
16	Data Acquisition Unit
17	PC Interface Software

Initial Specifications

Item # 28 Miscellaneous Equipment's

SR. NO.	WORKSTATION	SPECIFICATIONS
28/1	WATER COOLING TOWER (Bench-top)	1. Packing column: for the flow of hot water from top to bottom. The column should be made of acrylic preferably having following dimensions: L=28 inch, W= 6.5 inch, D=6.5 inch with packing of plastic plates, Thickness of acrylic column=5-6 mm sheet, Thickness of flange sheet=10-12 mm. (01 No.) 2. Air blower: Power= 1.0 hp, Flow rate = 120 Liter/sec. (01 No.) 3. Electrical heater: P1 = 0.5 KW, P2=1.0 KW. (02 No.) 4. Rotameter(acrylic/glass): Flow=0–5.0 liter/min. (01 No.) 5. Rotameter: for the measurement of air flow (01 No.) 6. Pump: Flow = 3-5 lit/min, (01 No.) 7. Temperature indicators: Thermocouple K-Type with individual no. of 06 display units (06 No.) 8. Manometer (Inclined tube): To find out the pressure drop across the column. (01 No.) 9. Water collection tank: Capacity=15-20 liters. (01 No.) 10. Water storage tank: Capacity=20-25 liters. (01 No.) 11. Electric panel
28/2	SHELL & TUBE HEAT EXCHANGER	1. Shell & Tube Heat Exchanger unit: should be made of metal (Stainless Steel) having no. of 1 Shell pass and no. of 2 Tube passes preferably having following specifications and dimensions: Thickness= 4mm, L= 20inch, SS pipe, D= 4inch, 1 SS tubes, L= 20inch, D_i=9mm, D_o= 12mm, 10-18 Baffles with 25% cut, 3 SS Flanges D= 6inch, Thick= 12mm, 4 SS nut & bolts, 16 Socket SS welded, D= 3/4inch, 4 all welded argon 2. Temperature indicators: Thermocouple K-Type with individual no. of 04 display units (04 No.) 3. Electric panel
28/3	PLATE & FRAME HEAT EXCHANGER	1. Plate type Heat Exchanger unit: should be made of metal (Stainless Steel) having no. of 7-10 plates, L= 14inch, W= 5 inch. (01 No.) 2. Rotameter (acrylic/glass): for both hot and cold fluid/water. (02 No.) 3. Temperature indicators: Thermocouple K-Type with individual no. of 04 display units for both hot and cold fluid/water (04 No.) as under: T_1=Temperature of inlet cold water, T_2=Temperature of outlet cold water, T_3 =Temperature of inlet hot water/steam, T_4=Temperature of outlet hot water/steam 4. Frame dimensions: H= 4ft, W= 3ft 5. Electric panel: L= 2ft, H= 10inch, B= 1ft (The panel should contain 04 temp. indicator lights, Pump and Heaters ON/OFF buttons etc.) 6. Hot water tank: L= 2ft, W= 1ft, H= 1ft. (01 No.) 7. Electrical heater: Power= 2.0 KW. (01 No.)
28/4	BATCH DISTILLATION COLUMN	1. Sieve plate column: should be made of metal (Stainless Steel) preferably having following dimensions: Column height= 1000mm, Column dia.= 50mm, No. of sieve plates= 6 (150 mm apart from each other). Holes area= 60 % of column area= 1178 mm^2, sieve plate hole dia.= 3mm, Pitch= 6mm (equilateral triangle pitch), Weir height= 15 mm, Weir length= 35 mm, down-comer width= 10mm, distance between bottom of down-comer and top of below plate= 10mm, Plate thickness= 3mm, Holes distance from column wall= 10 mm. (01 No.) 2. Still storage capacity: 12-15 Liters. (01 No.) 3. Electric heater (immersed): 1.0 KW with temperature controller (PID controller), Range= 5-100°C, Accuracy= ±0.5°C, (01 No.) 4. Temperature indicators: Thermocouples K-Type with individual no. of 02 display units for both top plate and Still (02 No.) 5. Top product tank: Capacity = 1-2 Liters 6. Horizontal condenser: = 150mm x 200mm (Shell & Tube type) Material of construction of all parts which are in contact with vapors & liquid should be of stainless steel. All equipments should be mounted on square steel pipe frame mounted on wheels. All the external parts should be sprayed/painted either black or grey.

SR. NO.	WORKSTATION	SPECIFICATIONS
5	AIR TRAY DRYER	**1. Air tray dryer unit:** should be able to investigate convection drying of solids on 4 corrosion resistant plates in a drying channel by air flow velocity via adjustable fan speed. It should have air heating with controlled heaters as well as sensors for measurement of humidity and temperature of solid samples before & after the completion of drying process. It should also be provided with digital weighing balance for measuring the overall change of weight during drying process. This unit should preferably be supplied with following specifications: **2. Drying channel length:** 2340mm (with fan), internal dimensions= 350x350mm **3. Fan power:** less than 100W, Max. output= 700m^3/h, max. speed >900 **4. Heater power:** 6000W (with adjustable temperature limiter) **5. Balance measuring range:** 0 to 10000g, resolution= 0.1g, **6. Measuring ranges:** Air humidity: 2 to 98% R.F., temperature= 0 to 100°C, flow velocity= 0 to 2.5m/s
6	GAS DIFFUSION APPARATUS	**1. Gas diffusion apparatus unit:** should have ability to separate CO_2/air mixture by absorption in counter flow with water. Production of gas mixture should be possible by using CO_2 from compressed gas cylinder and ambient air. Adjustment of mixing ratio should also be possible by using valves compressor for delivering the gas mixture into the absorption column. Continuous solvent regeneration in circuit with desorption column under vacuum. Water temperature control with heater and refrigeration system. **2. Absorption column height:** 2x 750mm, internal diameter= 80mm, **3. Desorption column height:** 750mm, internal diameter= 80mm **4. Pumps (absorption/desorption):** max. Flow rate= 17Lit/min (02 No.) **5. Pump (cooling):** max. Flow rate: 29Lit/min (01 No.) **6. Compressor:** max. Positive pressure= 1bar, max. flow rate= 4m^3/h **7. Measuring ranges:** Air flow rates= 0.4 to 40 Lit/min, Solvent= 40 to 430Lit/hr, CO_2= 0.5 to 6 Lit/min, temperature= 0 to 80°C, pressure= 0 to 2.5bar
7	CLIMBING & FALLING FILM EVAPORATOR	**1. Rising and falling film evaporator:** should preferably have these specifications. Shell dia. (O.D.)=2.5~3.5inch (SS), No. of tubes =2 mild steel (Copper), Outside dia. of each tube= 0.5inch, Effective length= 70inch, Heat transfer area=1.5ft^2. Top pipe dia. for vapor = 1 inch, Height of calendria = 6 inch, Tapered 3inch top flash tank: D= 6inch, L=12 inch, Top plate = 9 inch dia. (01 No.) **2. Temperature indicators:** Thermocouples K-Type with individual no. of 03 display units for both top plate and Still (03 No.) **3. Rotameter:** Flow rate max. =20 lit/hr, dia.= 2inch, L=10 inch **4. Temperature indicators:** Thermocouples K-Type with individual no. of 08 display units (08 No.) as: T_1=Feed inlet temperature (Pre-heater), T_2=Feed outlet temperature (Pre-heater), T_3=Steam chest temperature, T_4=Flash tank temperature, T_5=Product condensate inlet condenser, T_6=Product outlet condenser, T_7=Cooling water inlet condenser, T_8= Free **5. Feed Tank Dimensions:** L= 12inch, W= 12inch, H= 17inch **6. Frame Dimensions:** Length = 51inch, Width = 27 inch, H = 30 inch **7. Electrical Panel:** W= 16inch, L =19.5inch, H= 16inch. (01 No.) **8. Auxiliaries:** Steam pressure gauge, Condenser (shell and tube heat exchanger), Feed pre-heater (shell & tube heat exchanger).
8	FLOW-METER DEMONSTRATION APPARATUS	**1. The Unit:** should be fitted with different types of DP flow meters, gate valve, globe valves, manometer (water column) and by-pass lines preferably having following specifications. All equipments should be mounted on square steel pipe frame mounted on wheels. It will be suitable if piping material is PVC. (01 No.) **2. Venturi flow meter:** Throat diameter= 16mm, Upstream & downstream dia.= 26mm. (01 No.) **3. Orifice flow meter:** Orifice plate diameter= 12mm. (01 No.) **4. Rota meter (acrylic/glass):** Flow rate=0–5, 10 liter/min. (01 No.) **5. Storage tank:** 1.5'×1.5' (made of SS/acrylic and having drain valves) **6. Pump:** Power= 0.30 to 0.75 KW

SR. NO.	WORKSTATION	SPECIFICATIONS
9	ANALYTICAL SIEVE SHAKER	1. **Analytical sieve shaker:** should have a set of sieves and a controllable electromagnetic drive with preferably following features. (01 No.) 2. **Measuring range:** Particle size= 20 µm to 25 mm 3. **Sieving motion:** throwing motion with angular momentum 4. **Min. Batch / feed capacity:** 3 kg 5. **Min. Number of fractions:** 9/17 6. **Time display:** digital, 1-99 min 7. **Interval operation:** 10 sec 8. **Suitable sieve diameters:** 100mm/150mm/200mm/203mm (8") 9. **Max. Height of sieve stack:** 450mm This unit should be suitable for both dry and wet sieving as well as for a variety of materials applications, separation, fractioning, particle size determination including cement/clinker construction materials, chemicals, coffee, fertilizers, fillers, flours, grains, metals powders, minerals, nuts, plastics, sand, seeds, soils, slurries and suspensions etc.
10	PACKED-BED GAS ABSORPTION APPARATUS	1. **Packed-bed gas absorption unit:** should preferably be made of MS pipe 1.25 x 1.25 inches and all piping, feed tank and collecting tanks should be of good quality plastic/SS material. It should have a CO_2 cylinder with control valve, pressure regulator and pressure gauges for cylinder pressure and regulated pressure is supplied with the set-up for the absorption of CO_2 in water. The unit The unit must have 4 inch wheel for easy movement: 2. **Column:** Borosilicate glass /acrylic dia.= 40mm, Length= 1250mm 3. **Packing:** Borosilicate glass/ceramics rasching rings 4. **Pressure Regulator:** 0-2kg/cm^2 5. **Pressure Gauges:** Bourdon type 6. **Feed Tank Capacity:** 20 liters 7. **Electric Heater:** 1000 Watt, (To study the effect of temp. on gas absorption) 8. **Flow Measurement:** Rotameters (one each for feed water & CO_2) 9. **Collecting Tank Capacity:** 10 liters 10. **Feed Circulation:** By compressed gas.