Estd. – 2009
A Government Engineering College
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# PARALA MAHARAJA ENGINEERING COLLEGE

*(An Autonomous college affiliated to Biju Patnaik University of Technology, Odisha, Rourkela)*

**SITALAPALLI, BERHAMPUR, DIST.:-GANJAM, PIN – 761003**

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**No. PMEC/Estt./ 31** **Date:- 07/01/2022**

## CORRIGENDUM

## EXTENSION OF DATES AND MODIFICATION OF CHEMICAL ENGINEERING DEPARTMENT LABORATORY EQUIPMENT

**Ref:- Tender Notice No. PMEC/Estt./ 1805 Date:- 22/12/2021**

Due to some unavoidable circumstances, the dates for submission & opening of Tender Documents have been extended. The details are given below.

| Particulars | Earlier Dates | Extended Dates |
|---|---|---|
| Last Date of Receipt of Tender Paper | 20.01.2022 (up to 5.00 PM) | 07.02.2022 (up to 5.00 PM) |
| Opening of Technical Bids | 21.01.2022 (11.00 AM) | 08.02.2022 (11.00 AM) |
| Opening of Commercial Bids | 31.01.2022 (11.00 AM) | 18.02.2022 (11.00 AM) |

Further, the detail specification of Chemical Engineering Department Laboratory equipment has been modified, as mentioned below.

All other terms & conditions of the above mentioned Tender Package remains unchanged.

**Sd/-**
Principal
PMEC, Berhampur

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## LAB EQUIPMENT LIST WITH DETAIL DESCRIPTION
## DEPARTMENT OF CHEMICAL ENGINEERING, PMEC, BRAHMAPUR
## Mechanical Operation Lab

| Instrument Name | Specification | Qty |
|---|---|---|
| Sieve Shaker | Automation Type: Automatic<br>Compatible to sieves of 20-cm dia. (for 6-7 sieves)<br>Noise(dB): 1<br>Frequency: 50 Hertz<br>Motor Horsepower: 0.5-1 horsepower<br>Volatage: 220 Volt<br>Voltage (V): 220/230 Volts<br>Six Sieves: 6" to 8"<br>Outer Size: 14"x14"x6.5"<br>Rating Watts: 70<br>Special arrangement for setting time for shaking.<br>A. BSS NO. 4, 5, 6, 7, 8, 10, 12, 14, 16, 18, 22, 25, 35, 44, 52, 60, 72, 85, 100 to be provided.<br>Set of Lid and Pan to be provided.<br>Control Panel comprises of:<br>Standard make on off switch, Mains Indicator etc.<br>An ENGLISH instruction manual consisting of experimental procedures, block diagram etc. should be provided along with the Apparatus.<br>The whole set-up is well designed and arranged on a rigid structure painted with industrial PU Paint. | **One** |
| Hammer Mill | Material Stainless Steel 304 grade, Dia. 145mm, Depth 75mm<br>Feed Size: 6mm approx.<br>Product Size: (60-150) mesh approx.<br>Hammers: Material Stainless Steel, 4Nos. Size 55mm x 15mm<br>Anvil Plate: Material Stainless Steel b304 grade, Teethed Semi-circular.<br>Hopper: Material Stainless Steel 304 grade with discharge control arrangement<br>Discharge Chute: Suitable size<br>Drive: 1-3 HP, Single Phase motor,<br>Crompton/Standard make<br>Product Receiver: Material Stainless Steel 304 grade of suitable Size<br>Control Panel Comprises of:<br>Energy measurement: Electronic Energy meter.<br>Starter: Single Phase compatible to motor<br>MCB: For overload protection.<br>An ENGLISH instruction manual consisting of experimental procedures, block diagram etc. should be provided along with the Apparatus.<br>The whole set-up is well designed and arranged on a rigid structure painted with industrial PU Paint. | **One** |

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|---|---|---|
| Cyclone Separator | Power Source: Electric<br>Phase: Single Phase<br>Voltage: 220 V Ac<br>Power: 1 kW<br>Floor Area: 2 x 1 m<br>Material Stainless Steel 304 grade, Dia. 100 mm (approx.)<br>Solid Discharge Silo.: Material Stainless Steel 304 grade, suitable capacity with discharge control valve.<br>Blower: ID Fan Blower with 1 HP motor.<br>Pneumatic Feeding System must be provided.<br>Air flow measurement: Pitot with manometer.<br>Solids Collector: Transparent PVC container fixed with Cyclone.<br>Fine Dust Collector: Bag of Nylon cloth fixed on exit of air<br>Control Panel comprises of:<br>Standard make on off switch, Mains Indicator etc.<br>An ENGLISH instruction manual consisting of experimental procedures, block diagram etc. should be provided along with the Apparatus.<br>The whole set-up is well designed and arranged on a rigid structure painted with industrial PU Paint | **One** |
| Single Phase Plate Frame Filter Press | No. of Frame: 6<br>No. of Plates: 7<br>Size: 200 mm x 200 mm.<br>Material: Acrylic<br>Filter Medium: Filter Cloth<br>Filtrate collection tray: Material Stainless Steel 304 grade, Suitable size.<br>Filtration rate measurement: Using electronic sensor and digital display.<br>Material Stainless Steel 304 grade<br>slurry Feed tank: Material Stainless Steel 304 grade<br>Capacity 40-50 Ltrs.<br>Slurry Tank Agitator: Stainless Steel grade 304 Impeller with SS Shaft coupled to FHP Motor and Reduction Gear Box<br>Slurry Feed Pump: Gear Pump with FHP motor.<br>Piping system: GI and PVC.<br>Pressure Measurement: By Bourdon type pressure gauge-2Nos.<br>Overhead water tank: Material Stainless Steel 304 grade, Capacity 25-30 Ltrs.<br>Control Panel comprises of: Standard make on off switch, Mains Indicator etc.<br>Screw Jack made of Stainless Steel 304 grade arrangement for tightening and removing of frames easily.<br>An ENGLISH instruction manual consisting of experimental procedures, block diagram etc. should be provided along with the Apparatus.<br>The whole set-up is well designed and arranged on a rigid structure painted with industrial PU Paint. | **One** |
| Roll Crusher | Material Chilled Steel<br>Dia. 200mm, Width 100mm.<br>Drive: 2 HP motor coupled with Reduction<br>Gear Box to give 48-70 RPM<br>Feed Hopper: Suitable capacity.<br>Max feed Size: 6-8 mm.<br>Product Size: 1-2 mm.<br>Control Panel Comprises of:<br>Energy measurement: Electronic energy meter.<br>Starter: 2 HP, Single Phase,<br>MCB: For overload protection | **One** |

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|---|---|---|
| | The set-up is fitted with required guards and product collection tray.<br>An ENGLISH instruction manual consisting of experimental procedures, block diagram etc. should be provided along with the Apparatus<br>The whole set-up is well designed and arranged on a rigid structure painted with industrial PU Paint. | |
| Jaw Crusher | Jaw of size 100 x 150 mm should be fitted with Feed Hopper of Suitable capacity and Driven by Electric motor, 3 HP, Single phase.<br>Feed Size: 40-50 mm and Product Discharge Size 200 mesh.<br>Control panel should be comprised of Starter 3 HP, Single Phase and Calibrated electronic energy meter for power measurement to be required<br>The whole equipment should be fitted with on stand<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint. | **One** |
| Vibrating screen | Width 380mm, Length 600mm having variable stroke length.<br>Mesh: Size - 12.7 mm, 9.5mm and 6.3mm (Approx.)<br>Drive: Eccentric shaft coupled to Variable speed motor with VFD.<br>Feed Hopper: Compatible Capacity with arrangement to control feed.<br>Collecting bins: 4 Nos. made of Stainless steel 304 grade of suitable capacity<br>Control Panel comprises of:<br>Standard make on off switch, Mains Indicator etc.<br>An ENGLISH instruction manual consisting of experimental procedures, block diagram etc. should be provided along with the Apparatus.<br>The whole set-up is well designed and arranged on a rigid structure painted with industrial PU Paint. | **One** |
| Ball mill | Material MS, Dia. 275mm, Length 350mm. Thickness 4 mm<br>Discharge Chute: Suitable size.<br>Feed Size: 6 mm<br>Product Size: 200 mesh<br>Drive: 1 HP, 3 phase variable speed motor coupled to Reduction Gearbox with VFD Drive.<br>Product receiver: Material Stainless Steel of suitable size.<br>Control Panel Comprises of:<br>RPM measurement: By proximity sensor with Digital Indicator, Energy measurement: Electronic Energy meter, RPM Measurement: Digital RPM Indicator, Non-Contact type with Proximity sensor and VFD Drive should be provided.<br>The set-up is fitted with required guards.<br>An ENGLISH instruction manual consisting of experimental procedures, block diagram etc. should be provided along with the Apparatus.<br>The whole set-up is well designed and arranged on a rigid structure painted with industrial PU Paint | **One** |

# Fuel Technology Lab

| Instrument Name | Specification | Qty |
|---|---|---|
| Bomb Calorimeter | Fully automatic with PLC touchscreen colored display<br>Single Unit: no assembly required<br>With automatic oxygen filling, direct reading on the screen, standardization facility and memory storage of 400 data<br>Temperature resolution- 0.001-degree c and RSD +/- 1 percent.<br>With 100 tablets of 1gm benzoic acid or known calorific value(imported)<br>Used for determination of combustion of heat of calorific value of the fuel & other organic material<br>Supplied complete with water jacket made of Brass/S.Steel sheet duly nicked chromium plated with Bakelite Lid<br>S. Steel Bomb, Bomb Jacket Water Calorimeter Vessel<br>Motorized heavy duly stirrer for uniform Circulation<br>Briquette, Pet tel Press heavy duly<br>Firing unit with illumination<br>Vibrator & Buzzer, spanners, magnified glass with nickled nichrome wire & Cotton reel<br>Gas Releasing Valve, S.Steel crucible<br>Benzoic Acid with known calorific value<br>Full feature digital controller & Safety device | **One** |
| Flash And Fire Point Apparatus | Pen sky marten flash point tester closed cup as per IP-34, ASTM D 93 & IS 1448(P-21) Electrically heated model with motorized stirrer with digital temperature controller.<br>Machine Type Oil Testing<br>Automation Grade: Semi-Automatic<br>Standard: ASTM<br>Power Source: Electric<br>Voltage: 220-380V<br>Frequency: 50-60 Hz | **One** |
| Aniline Point Apparatus | As per IP 2 method B ASTM D 611 by thin film method B,<br>Elect. Heated with Elect. Stirrer<br>Electrical Screw type Pump with Auto tuned PID Single Ramp Rate Digital Temperature Controller cum Indicator (Dual Display) coupled with PT-100 RTD Sensor & Motorized Blower for Cooling effect (without thermometer) & DC Lamp As Illumination<br>Material: Borosilicate Glass<br>Capacity: 100 Nos<br>Voltage: 220-240V<br>Frequency: 50-60 Hz | **One** |
| Cloud And Pour Point Apparatus | Generally, as per ASTM D 97, ASTM D 2500 & equivalent test methods.<br>Digital temperature display with resolution of 0.1°C.<br>Temperature control to within ± 1°C. Long life, high safety zone, stainless steel immersion heaters, Automatic low liquid level safety cut-off & drain to empty tank almost fully, Seamless copper jackets, with disks, gaskets, test jars, corks, Non-CFC, future safe, environment friendly refrigeration stainless steel tanks, powder coated exterior, PUF insulation, wheels for easy mobility.<br>Single Tank, with 4 test positions, with temperature settings with resolution of 0.1°C for tests at successively lower temperatures, with four sets of jackets, jars, disks, gaskets and corks. With minimum temperature of -30°C. | **One** |

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|---|---|---|
| Brookfield Touch Screen Viscometer | Classification<br>Viscosity Test Types Multi Point<br>Construction<br>Torque Calibration Automatic<br>Permissible ambient temperature 40 degree Celsius<br>Current consumption 1.2 milliAmpère<br>Operating Temperature Range 40 degree Celsius<br>Accuracy 1.0 %<br>Temperature Probe 300 degree Celsius<br>RPM Resolution 0.1<br>Permissible relative humidity <80 %<br>Input Supply Types AC<br>Viscosity Range, mPa.s 1 to 6M<br>Software Stand Alone,Optional<br>Mode RPM,Shear Rate,Automatic<br>Motor rating output 4.8 Watt<br>Input Power Supply 100-240 VAC<br>Repeatability 0.2 %<br>Spring torque, mNm ,max 0.0673<br>Speed, RPM 0.1-200<br>Alignment NA<br>Power input standby 0.06 Watt<br>Frequency, Hz 50 - 60<br>Time setting range 1 minute<br>Spindle MOC SS<br>ISO Standard ISO2555,ISO3219,ISO 12058,NA<br>Spindle Coupling Push and Plug<br>Power Input 24 Watt<br>Dimensions<br>Length, mm 350 - 400<br>Support rod diameter (with integrated fastening on stand) 16 millimeter<br>Weight, kg 5 - 10<br>Height , mm 400 -500<br>Width, mm 350 - 400<br>Additional Information<br>Overload protection Yes<br>Touch function Yes<br>Display LCD<br>Warranty 1 year<br>Timer No<br>Direction of rotation Clockwise<br>Interface USB | **One** |

# Fluid Flow & Flow Measurement Lab

| Instrument Name | Specification | Qty |
|---|---|---|
| Pitot Tube Apparatus | Test section should be made of clear Acrylic and compatible to 1" Dia. Pipe.<br>Pitot Tube should be made of brass or copper.<br>Water circulation should be done by ½-1 HP Pump, Crompton/standard make, from sump tank, 1.2 mm thick, Capacity 50 liters and flow measurement should be done by measuring tank, 1.2 mm thick, Capacity 25 liters, made of stainless steel 304 Grade, with piezometer tube and electronic stopwatch.<br>Pressure Measurement should be done by differential water manometer.<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint<br>Pump Warranty: 2 years | **One** |
| Orifice meter Apparatus | Test section should be made of clear Acrylic and compatible to 1" Dia. Pipe.<br>Orifice plate should be made of Stainless Steel 304 grade<br>Water circulation should be done by ½ HP Pump, Crompton/standard make, from sump tank, 1.2 mm thick, Capacity 50 liters and flow measurement should be done by measuring tank, 1.2 mm thick, Capacity 25 liters, made of stainless steel 304 Grade, with piezometer tube and electronic stopwatch.<br>Pressure Measurement should be done by differential water manometer.<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint<br>Pump Warranty: 2 years | **One** |
| Venturi Meter Apparatus | Test section should be made of clear Acrylic and compatible to 1" Dia. Pipe.<br>Ventrui Nozzle A = 84 to 338mm$^2$, angle at the inlet 10.5$^0$, angle at the outlet 4$^0$<br>Water circulation should be done by ½ HP Pump, Crompton/standard make, from sump tank, 1.2 mm thick, Capacity 50 liters and flow measurement should be done by measuring tank, 1.2 mm thick, Capacity 25 liters, made of stainless steel 304 Grade, with piezometer tube and electronic stopwatch.<br>Pressure Measurement should be done by differential water manometer.<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint<br>Pump Warranty: 1 year | **One** |
| Centrifugal pump test | Centrifugal pump, Kirloskar Make, Capacity 1 HP, Speed 2800 RPM (max.), Head 12 m (max.) should be coupled with a AC Motor with Thyristor controlled AC drive for variable speed. RPM sensor having resolution of 0.0001428 & least count 0.00857 RPM and MTTF of 200 years with digital display. Cavitations effect should be visible<br>Transparent housing for impeller should be provided for students to see the effects.<br>Water circulation from sump tank, 1.2 mm thick, Capacity 90-120 liters, made of stainless steel 304 Grade and flow measurement should be done by measuring tank, 1.2 mm thick, made of stainless steel 304 Grade, Capacity 70 liters, with piezometer tube and electronic stopwatch.<br>Bourdon type Pressure Gauge for pressure measurement. Control panel should be comprising of Mains Indicator and MCB for overload protection | **One** |

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| Reynolds Apparatus | Test section tube should be vertical, made of Borosilicate Glass having ID 12 mm approx., Length: 700 mm approx.<br>Capillary Tube should be provided, Material copper/ Stainless Steel 304 grade.<br>Dye vessel should be provided Material Stainless Steel 304 grade<br>Constant Head Water Tank: Material Acrylic, with glass beads for smooth & even flow.<br>Centrifugal pump: 1/2 HP, Crompton/Standard make<br>Flow measurement: Measuring cylinder and stopwatch<br>To study laminar to turbulent transition in pipe flow<br>Introduces basic concepts of stability, flow patterns, streaklines and streamlines | **One** |
| Bernoulli's Theorem Apparatus | Ventrui Nozzle A = 84 to 338mm$^2$, angle at the inlet 10.5$^0$, angle at the outlet 4$^0$. Orifice meter dia 14mm, pitot tube should be provided.<br>Each and every accessories put in a single pipe line there should be no other pipe line installed in a set up<br>Six tube manometers should be provided along with rotameter.<br>Water circulation should be done by ½ HP Pump, Crompton/standard make, from sump tank, 1.2 mm thick, Capacity 50 liters and flow measurement should be done by measuring tank, 1.2 mm thick, Capacity 25 liters, made of stainless steel 304 Grade, with piezometer tube and electronic stopwatch | **One** |
| Reciprocating Pump Test | Double acting, Single Cylinder Reciprocating Pump should have Capacity 1 HP, Speed 250 RPM and Head 5 kg/cm$^2$, coupled with a 1HP DC Motor with Thyristor controlled DC drive for variable speed.<br>RPM sensor having resolution of 0.0001428 & least count 0.00857 RPM and MTTF of 200 years with digital display.<br>Water circulation from sump tank, 1.2 mm thick, Capacity 50 Ltrs and flow measurement should be done by measuring tank, made of stainless steel 304 Grade, 1.2 mm thick, Capacity 25 Ltrs, with piezometer tube and electronic stopwatch.<br>Pressure gauge should be provided for pressure measurement.<br>Digital RPM Indicator with Proximity sensor, MCB for overload protection and Electronic Energy meter for power measurement.<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint<br>Pump Warranty: 1 year | **One** |
| Flow Over Notch Apparatus | Channel test section should be of Size 600 x 250 x 180 mm and made of stainless steel 304 Grade.<br>Three types of notches i.e., Rectangular Notch, 45° V Notch and 60° V Notch should be made of brass.<br>Trapezoidal Notch should be provided.<br>A pointer gauge with vernier scale for measuring the height of fluid over the notch in flow channel should be provided.<br>Water circulation should be done by ½ HP Pump, Crompton/ Standard make, from sump tank, 1.25mm thick, capacity 50 liters made of stainless steel 304 Grade.<br>Water flow measurement should be done by measuring tank, 1.5 mm thick, made of stainless steel 304 Grade, capacity 25 liters, with piezometer tube and electronic stopwatch. The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint.<br>Pump Warranty: 1 year | **One** |

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| Fluidized Bed Set Up | Column: Material Borosilicate Glass with both end made of Stainless Steel<br>Dia. 48 mm (approx.)<br>Height 750 mm (approx.)<br>Packing: Glass Beads (3-4 mm)<br>Water tank: Material Stainless Steel<br>Capacity 30 Ltrs<br>Water Circulation: FHP Pump Crompton/Sharp make.<br>Water Flow Measurement: By Rotameter<br>Pressure Drop Measurement: Manometer | **One** |

## Heat Transfer Lab

| Instrument Name | Specification | Qty |
|---|---|---|
| Composite Walls Apparatus | Slab assembly arranged symmetrically on both sides of heater.<br>Slab Material: Slab Size<br>Cast Iron: 250 mm dia. 20mm thick.<br>Bakelite: 250 mm dia. 15 mm thick.<br>Press Wood: 250 mm dia. 12 mm thick.<br>Heater: Nichrome Wire Heater.<br>The slab assembly with front window of glass/acrylic.<br>The whole set-up is ingeniously designed and schematically arranged on a powder-coated rigid structure.<br>**Control Panel:**<br>Variance: 0-230 V, 2Amp.<br>Digital Temp. Indicator: 0-200$^0$C, with multi-channel switch<br>Temp Sensors: RTD PT-100 type.<br>Standard make On/Off switch, Mains Indicator etc.<br>Cabinet should be provided to accommodate the slab assembly with front window of acrylic.<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint. | **One** |
| Thermal Conductivity of Liquids Apparatus | Liquid chamber of inner Dia. 40 mm, Length 120 mm should be made of Aluminium.<br>Cooling chamber of Inner Dia. 70 mm, Length 110-120 mm for water circulation should be made of stainless steel 304 Grade.<br>Rod type heater should have Outer Dia.: 38 mm and Length 110-120 mm and temperature controlled by PID Controller, 0 -199.9° C.<br>Temperature measurement should be done by Temperature Sensors of RTD Pt-100 type with Digital Temperature Indicator (0-199.9 °C).<br>Power measurement should be done by watt-hour pulse indicator.<br>Valves should be provided for drain & charging line to make system flexible.<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint | **One** |
| Stefan Boltzman Apparatus | Hemisphere of Dia.- 200 mm (approx.) should be made of Copper.<br>Jacket of Dia. 250 mm (approx.) should be made of Stainless Steel 304 Grade.<br>Test Disc Size of 20 mm Dia. x 1.5-mm thickness should be made of Copper.<br>Water Tank should be made of Stainless Steel 304 Grade of capacity 12 Ltrs.<br>Heat input to the Nichrome wire immersion heater should be controlled by PID Controller, 0-199.9° C. | **One** |

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| | Temperature measurement should be done by Temperature Sensors of RTD PT-100 type with Digital Temperature Indicator (0-199.9 °C).<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial | |
| Shell and tube heat exchanger | Equipment should perform the experiment of parallel flow and counter flow heat exchanger.<br>Equipment should perform the experiment of parallel flow and counter flow heat exchanger.<br>Shell should made of Clear Acrylic, with suitable baffles<br>Fourteen tubes should be made of stainless steel 304 grade having ID 5 mm, OD 6 mm and Length 150 mm.<br>Hot water circulation by Magnetic Pump (capable of working up to 95°C), from hot water tank, made of stainless steel 304 Grade, 1.2 mm thick, insulated with ceramic wool and fitted with Nichrome wire heater digitally controlled by closed loop PID controller 0-200 °C.<br>Cold water and hot water flow rate should be measured by Rotameters<br>Temperature measurement should be done by Temperature Sensors of RTD PT-100 type with Digital Temperature Indicator (0-200 °C).<br>One ceramic bare temperature sensor to be welded on test section directly. There will be no other material in between<br>Ceramic sensor and test specimen to avoid any losses<br>Valves should be manufactured as per EN ISO 9001 standard and 100% tested in accordance with EN 12266-1 standard | **One** |
| Parallel Flow Counter Flow Heat Exchanger | Water to Water, concentric tube type Heat exchanger of Length 1.6 m should be insulated with ceramic wool and cladded by aluminum foil.<br>Outer Tube of ID 27.5 mm and OD 33.8 mm (approx.) and Inner Tube of ID 9.5 mm, OD 12.7mm (approx.) should be made of Stainless steel 304 Grade.<br>Water Flow Measurement should be done by Two Rotameters one each for cold & hot fluid. Hot Water Circulation should be done by Magnetic Pump from Hot Water Tank, 1.2 mm thick, made of Stainless steel 304 Grade, insulated with ceramic wool and fitted with Two Nichrome wire heaters.<br>Heat input to the heater should be controlled by PID Controller, 0-200° C.<br>Temperature measurement should be done by Temperature Sensors of RTD PT-100 type with Digital Temperature Indicator (0-200 °C). | **One** |

## Chemical Reaction Engineering Lab

| Instrument Name | Specification | Qty |
|---|---|---|
| CSTR | Reactor of Capacity 2 Ltrs should be made of Stainless Steel 304 Grade and fitted with Stirrer having Stainless Steel Impeller and shaft coupled with FHP Motor.<br>Feed Circulation should be done by compressed air from Feed Tanks, 1.2 mm thick, capacity 20 liters each, made of stainless steel 304 Grade and Flow Measurement by Rotameter.<br>Piping should be of Stainless Steel and PU pipe.<br>Bourdon type pressure gauge of 0-2 $Kg/cm^2$ and Pressure Regulator of 0-2 $Kg/cm^2$ should be provided.<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint. | **One** |

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| Isothermal Plug Flow Reactor (PFR) | Helical Coiled Tube Type Reactor of Volume 0.6-0.7 Litres should be made of stainless steel 304 Grade.<br>Double walled Water Bath, insulated with Ceramic Wool should be fitted with stirrer having Impeller and shaft coupled with FHP motor and Nichrome wire Heater whose temperature controlled by PID Controller, 0-199.9° C.<br>Feed Circulation should be done by compressed air from Feed Tanks, 1.2 mm thick, capacity 20 liters each, made of stainless steel 304 Grade and Flow Measurement by Rotameters.<br>Piping should be of Stainless Steel and PU pipe.<br>Bourdon type pressure gauge of 0-2 Kg/cm$^2$ and Pressure Regulator of 0-2 Kg/cm$^2$ should be provided.<br>Temperature measurement should be done by Temperature Sensors of RTD PT-100 type with Digital Temperature Indicator (0-199.9 °C).<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint. | **One** |
| Packed bed reactor | Reactor Column of Volume 1.2 Ltrs packed with Rasching Rings, Size 6-8 mm, should be made of Borosilicate Glass.<br>Feed Circulation should be done by compressed air from Feed Tanks, 1.2 mm thick, capacity 20 liters each, made of stainless steel 304 Grade and Flow Measurement by Rotameter.<br>Piping should be of Stainless Steel and PU pipe.<br>Bourdon type pressure gauge of 0-2 Kg/cm$^2$ and Pressure Regulator of 0-2 Kg/cm$^2$ should be provided.<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint. | **One** |

## Process Dynamic Control Lab

| Instrument Name | Specification | Qty |
|---|---|---|
| Two Tank Interaction System | Process Tank: Material acrylic, Circular, with graduated level scale (2 Nos.), Capacity 3.5 litres (approx.)<br>Supply Tank: Material Stainless Steel 304 grade, Capacity 20 litres.<br>Overhead tank: Material Stainless Steel 304 grade, Capacity 5 litres.<br>Water Circulation: FHP Pump, Champion/Standard make.<br>Piping: SS & PVC, size ¼"<br>Flow Measurement: By Glass tube Rota meter.<br>The whole unit is assembled rigidly on a base plate<br>An ENGLISH instruction manual consisting of experimental procedures, block diagram etc. should be provided along with the Apparatus.<br>The whole set-up is well designed and arranged on a rigid structure painted with industrial PU Paint. | **One** |
| Two Tank Non-Interaction System Apparatus | Process Tank: Material acrylic, Circular, with graduated level scale (2 Nos.), Capacity 3.5 litres (approx.)<br>Supply Tank: Material Stainless Steel 304 grade, Capacity 20 litres.<br>Overhead tank: Material Stainless Steel 304 grade, Capacity 5 litres.<br>Water Circulation: FHP Pump, Champion/Standard make.<br>Piping: SS & PVC, size ¼"<br>Flow Measurement: By Rotameter.<br>The whole unit is assembled rigidly on a base plate.<br>An ENGLISH instruction manual consisting of experimental procedures, block diagram etc. will be provided along with the | **One** |

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| | Apparatus.<br>The whole set-up is well designed and arranged on a rigid structure painted with industrial PU Paint. | |
| Temperature Control Trainer | Temperature Transmitter: Input RTD PT-100 (Range 0-100°C), Output 4-20 mA.<br>Process tank: Material Stainless Steel 304 grade, Capacity 0.5 lit (approx.)<br>Heater: Nichrome Wire Heater, Capacity 1 kW<br>Thyristor Controller: Input 4-20mA for heater.<br>Flow Measurement: By flow sensor & Glass tube rota meter<br>Piping: Size 1/4”<br>Interfacing unit: For input-output communication with auto/manual facility<br>Micro-processor Controller: PID Setting, auto tuning, fully programmable with serial communication<br>Software should be SCADA based: For experimentation, PID control, Data logging, trend plot, offline analysis and printing<br>One ceramic bare temperature sensor to be welded on test section directly. There will be no other material in between ceramic sensor and test specimen to avoid any losses & Equipment should be run in both computerized and non-computerized mode.<br>An ENGLISH instruction manual consisting of experimental procedures, block diagram etc. should be provided along with the Apparatus.<br>The whole set-up is well designed and arranged on a rigid structure painted with industrial PU Paint | **One** |
| Pressure Control Trainer | Pressure Transmitter: Range 0-5 bar, type strain gauge, output 4-20 mA.<br>Process Tank: Material Stainless Steel 304 grade, Capacity 1.5 Ltrs.<br>Control Valve: Compatible capacity with Pneumatic Actuator.<br>I/P converter: Input 4-20mA, Output 3-15 PSIG.<br>Pressure Regulator: 0-2 kg/cm².<br>Pressure Gauge: Bourdon type, 0-2 kg/cm², 0-7 kg/cm²<br>Piping: P.U.<br>Interfacing unit: For input-output communication with auto/manual facility<br>Micro-processor Controller: PID Setting, auto tuning, fully programmable with serial communication<br>Software should be SCADA Based: For experimentation, PID control, Data logging, trend plot, offline analysis and printing<br>Compressed air supply should be provided & computer system should be in the scope of supplier.<br>An ENGLISH instruction manual consisting of experimental procedures, block diagram etc. should be provided along with the Apparatus.<br>The whole set-up is well designed and arranged on a rigid structure painted with industrial PU Paint. | **One** |
| Single Tank System | A circular Process tank with graduated level scale should have Capacity 3- 4 litres, made of Glass (No other material should be accepted)<br>Water circulation by FHP Pump, Crompton/Standard make, from sump tank, 1.2 mm thick, Capacity 20 Ltrs to overhead tank, 1.2 mm thick, Capacity 5 Ltrs, made of stainless steel 304 Grade.<br>Flow measurement should be done by Glass tube Rota meter (Make or model should be mentioned in the technical specifications). | **One** |

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| | Calibration Certificate should be supplied along with the set up.<br>Piping should be of SS & PVC and size ¼".<br>The whole set-up should be well designed and arranged on a rigid structure painted with industrial PU Paint. | |

## Composite Material Synthesis Lab

| Instrument Name | Specification | Qty |
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| Magnetic Stirrer with Hot-Plate | Material: Mild Steel<br>Speed Range:100-2000 Litre<br>Dimensions: 300 x 110 x 226 mm<br>Finishing Type: Color Coated<br>Heating Temperature Range: Up to 350$^{o}$C<br>Maximum Stirring Quantity: 5 Liter<br>Speed Display Resolution: 1 RPM<br>Top Plate Dimensions:190 x 190 mm<br>Temperature Accuracy: +-0.5$^{o}$C<br>Wattage: 600 Watt<br>LCD Display of Real-time Speed & Temperature<br>Chemical & Scratch Resistant Ceramic Top Plate<br>Adjustable Thermometer Rack, Stainless Steel Rods & Stir Bar | **One** |
| Probe Sonicator | Usage/Application: Laboratory<br>Material: Aluminum Alloy<br>Features: fully automatic<br>Phase: Single<br>Operating Voltage: 240 V<br>Capacity: 1-300ml<br>Ultrasonic Power: 250 W<br>Frequency (KHz): 20<br>Timer: Cyclic ON / OFF<br>Piezoelectric frequency energy converter: Lead zirconate TITANIUM<br>(PZT) pyro electric ceramics.<br>Standard probe: Titanium Alloy material Diameter (probe):6mm<br>Variable Amplitude Control<br>Micro Based, processer, Digital Display with user prompts<br>Full Function pulsar ON & OFF<br>Laboratory Jack | **One** |
| Rota Vapor/ Rotary Evaporator | Material: Stainless Steel<br>Capacity: 1-3 ltr<br>Temperature Range: 0-100 $^{o}$C<br>Automation Grade: Automatic<br>Features: Autolift with Brushless DC drive and data logging<br>Power Supply 230V, 50 Hz<br>Bath Size: 5 ltr<br>Condenser: cooling coil<br>Rotary vacuum evaporator<br>Digital RPM indicator cum control with DC drive, Speed: min.: 50 to 280<br>Vacuum Glassware<br>Vertical Glass Set: Consisting of pear-shaped evaporating Flask of 1.0 L capacity,<br>Round bottom receiver flask Cap:1.0 L, Vertical condenser with at | **One** |

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| | least 1200 cm2 or more cooling area; PTFE feed tube with PTEF feed stop cock and all required accessories including flask adapter silicon water tube.<br>Vacuum Controller: Digitally display range: 0 to 1000-11000 mbar, Resolution: 1 mbar, Accuracy: 3 mbar or more | |
| Muffle Furnace | Input Voltage: 240 V<br>Voltage: 415 V AC supply.<br>Temperature Accuracy: +-2 Degree C<br>Programmable Power Controller: Data Software Logging<br>Maximum Temperature: 1700oC<br>Working Temperature: 1600oC<br>Heating Elements: Molybdenum Disilicide ($MoSi_2$) Heating Element, Easily Replaceable<br>Power Supply: 415 Volts, 2/3 phase AC supply<br>Insulation: Ultra high purity alumina low thermal mass insulation | **One** |
| Auto Titrator | Resolution: 0.01ph<br>Voltage Range: 110 to 240V<br>PH Measuring Range: 0.00 pH to 14.00 pH<br>MV Measuring Range: 0 to 2000mV<br>Temperature Measuring Range: 0 $^{o}$C to 100 $^{o}$C<br>Repeatability: 0.20 %<br>Power: 110 to 240V<br>Size: 155 x 86 x 22mm<br>Weight: Approx. 223g<br>Measure range (ppm): 0 ~ 14.00ph<br>Accuracy: 0.005 mm<br>Burette volume tolerance:<br>Burette20mL±0.035mL<br>Zero-dead volume solenoid valve changing easily for PTFE burette.<br>Ultrathin stirring device, adopt coil realize magnetic Stir.<br>Accuracy closed-loop control for volume.<br>High-accuracy burette accurate to 0.005mm.<br>Simple design, discrete stirring unit, detachable easily.<br>LCD touch screen.<br>Wide operating voltage range 110~240V | **One** |
| Polymer film making equipment | 15-ton laboratory hydraulic press<br>Heating arrangement with temperature controller indicator and necessary plumbing for water circulation for cooling<br>Accuracy: ±5 $^{o}$C<br>Temperature: Ambient to 350 $^{o}$C<br>Platen size: 120 mm x 120 mm<br>Platen specimen: 100 mm x 100 mm<br>Cooling: by water circulation<br>Overall dimensions: 380 x 240 x 375 mm | **One** |

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