

<b>भारतीय प्रौद्योगिकी संस्थान ततरुपतत</b> <b>Indian Institute of Technology Tirupati</b> Settipalli, Renigunta Road Tirupati 517506	दूरभाषसंख्या Phone no: 0877 – 2500335 ईमेल Email : govindak@iittp.ac.in
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**Prof. T.S. Natarajan**  
 Registrar i/c

**Date: May 08, 2018.**

**Public Tender No: IITT/MECH/08/2018-19/03**

**Due Date: 31- 05-2018 at 3.30PM**

Dear Sir/Madam,

On behalf of the **Indian Institute of Technology TIRUPATI**, sealed quotations are invited in two part bid system for supply of **following laboratory equipments to IIT Tirupati Transit Campus Venkatagiri Road, Yerpedu Mandalam, Chittoor District, Andhra Pradesh:**

S.No.	Experimental setup	Quantity
1	Bomb Calorimeter	1 No.
2	Single cylinder gasoline engine with computer control setup	1 No.
3	Twin cylinder turbocharged diesel engine with EGR and Computer control set up.	1 No.
4	Pelton Turbine setup	1 No.
5	Francis turbine setup	1 No.
6	Propeller turbine setup	1 No.
7	Centrifugal pump setup	1 No.

**Specifications and compliance statement:**

The detailed specifications of the above equipment are given in the Annexure "A" and the same should be complied with. If any deviations, it should be clearly stated in the technical bid. Technical literature/leaflet showing the compliance of the specification may also be attached with the quotation.

Please ensure that the specifications are basic essence of the product. It must be ensured that the offers must be strictly as per our specifications. At the same time it must be kept in mind that merely copying of our specifications in the quotation shall not make the parties eligible for consideration of the quotation. A quotation has to be supported with original catalogue (not of photo copy) of the quoted model duly signed by the principals and the same must be sent along with the technical bid. The quoted model should not become obsolete for a minimum period of 5 years (This is for the availability of spares). Therefore the model quoted should invariably be highlighted in the leaflet/literature enclosed with the quotation. Non-compliance of the above shall be treated as incomplete/ambiguous and the offer can be ignored without giving an opportunity for clarification/negotiation etc. to the bidder.

**The eligibility criteria for participation in bid are mentioned below:**

- a) The Bidder must be an Original Equipment Manufacturer (OEM) or his Authorized Dealer/ Channel Partner having a Direct Purchase and Support agreement with the OEM. In case, the

Bidder is a Dealer, a valid LETTER OF AUTHORIZATION from Original Equipment Manufacturer should be produced along the bid.

### **Performance Certificate:**

- a) The quoted system and accessories must have been supplied and installed at least one such similar system/equipment to any of the Central/State Govt./ PSUs/Universities/IITs/Autonomous bodies/any firm and proof of supply by producing copy of Purchase Order and its working condition is a mandatory and must be produced along with the bid document.
  - b) The bidder should also provide test results of the intended equipment.
  - c) The bidder should also provide details of technical support staff with their qualification and experience.
  - d) The bidder should be willing to arrange for a demonstration of the equipment offered at free of charge on mutually agreeable place and date prior to opening of price bids to ascertain their conformity with tendered specifications.
1. The technical bid shall be evaluated for acceptability by the technical committee and may call the tenderers for discussion. If necessary, the committee may modify the technical specification to suit the requirement of IIT Tirupati. In such case the opportunity shall be given to the participating bidders for submitting the revised bid as per modified specifications, if any.
  2. List of Present Clientele to whom identical or similar equipment supplied in the preceding three years must be produced with contact addresses & telephone numbers.
  3. Vendor shall possess ISO 9000 certification for Quality System implementation. Required evidence shall be provided along with offer.
  4. Bidder should be registered under **GST** Act with concerned State Sales Tax Authorities. The bidder should furnish along with the bid document, the relevant **GST** Registration Document and PAN / TAN copies.

The supplier should quote commercially proven model of equipment or control system. Prototypes are not acceptable.

The above mentioned basic eligibility conditions are broad guidelines for pre-qualification and the Director/Registrar in-charge, IIT Tirupati hereby reserves the right to relax / alter / modify / add any or all the conditions.

**Delivery schedule:** The total system should be supplied within 2 months from the date of receipt of Purchase Order and installation and commissioning should be completed within 20 days from the date of supply of equipment..

**The interested bidders are advised to go through the conditions envisaged for eligible criteria for participation in the bidding.**

### **Instructions to the Bidder**

- (i) **Preparation of Bids:** The bidders must ensure that bids are submitted in **two part bid system (i.e.) Technical bid and Financial bid in separate envelopes.**
- (ii) **Techno-commercial bid:** The technical bid should consist of all technical details/brochures along with commercial terms and conditions super-scribed as

TECHNICAL BID with Tender No. and date and time of closing and the bidder's name and address. No prices should be included in technical bid.

(iii) **Financial (Price) Bid** should indicate item-wise prices for the items with firm and fixed figures and words super-scribed with the Tender No. and date of closing of the Tender with name of supply/work and the bidder's Name and address. The price bid should not contain any conditional clauses. No price escalation for any reasons whatsoever is allowed. Preferable all prices should be given in Indian Rupees or USD or Euros. The Indian bidders shall quote firm price fully in Indian currency only.

(iv) The techno-commercial bid and the financial bid duly signed by the bidders or their authorised signatories with name and seal should be put in separate cover and sealed. Both sealed covers should be put into a bigger cover duly super-scribed with Public Tender No. and due date/time with name of supply /work. **Technical bids must either be spiral bound / stapled together. No loose sheets will be accepted. All pages must be numbered.**

(v) **Submission of the tender:** The complete sealed bids in all respects shall be sent to the following address well in advance either by post or by courier so as to reach this office on or before the due date and time specified in the Schedule. The bids received after closing date and time shall not be considered.

The Registrar I/C,  
Indian Institute of Technology Tirupati,  
Renigunta Road,  
Settipalli Post,  
Tirupati-517 506, Andhra Pradesh

While submitting the bids, the bidders must sign all the tender documents as a token of accepting of tender documents as well as terms and conditions stipulated therein. Tender documents without signature of bidders or their authorised signatories will be treated as invalid bids.

No conditional offer or terms and conditions will be entertained by the institute and such bids will be treated as invalid.

(vi) The tender documents can be down loaded from IIT Tirupati web site:<http://iittp.ac.in/tenders> on or after **10-05-2018**

(vii) **Bid Security (EMD):** *EMD either in the form of* Bank Guarantee or Demand draft at 2% of the quoted value initially valid up-to 90 days drawn in favour of Indian Institute of Technology Tirupati payable at Tirupati must be sent along-with the technical bid only. The technical bid without EMD would be considered as UNSOLICITED and will be REJECTED. Photo/FAX copies of the Demand Draft/Banker's pay orders will not be accepted. No interest will be paid for the EMD and the EMD (Bid Security) will be refunded to the successful bidder on receipt of Performance Security (Security Deposit) and in case of unsuccessful bidders, the EMD will be refunded on finalisation of tender.

- Micro and Small Enterprises (MSEs) registered with National Small Industries Corporation are exempted from payment of Earnest Money Deposit. However, vendors covered under this category have to submit copy of registration certificate along with technical bid. Failing which, the bid will be disqualified.

(viii) Bid security be forfeited without any intimation in such cases as below:-

- a) If a bidder withdraws its bid during the period of bid validity
- b) If a successful bidder fails to execute the awarded contract
- c) If a successful bidder fails to provide performance guarantee

**(ix) Details of our Banker**

Name of bank	State Bank of India
Address of bank branch	Settipalli Branch Renigunta Road, Tirupati
Bank Branch code	006677
IFS Code	SBIN0006677
Bank Account Number	35523338208

**Modifications to bid:**

- (x) The bidder shall make no modifications to the bids after the closing date unless specifically requested by IIT Tirupati. In case certain clarifications are sought by Institute after the opening of bid, then the reply of bidder should be restricted to the clarifications sought. Any bidder who modifies his bid having effect of altering the value of his offer after the closing date without specific reference by IIT Tirupati shall make him-self liable to be debarred from this tender and forfeit the bid security amount.

**xi) Modifications of specification:**

The supply to be made by the Supplier under this Purchase order can be modified or changed by the request from the IIT Tirupati provided that for such modifications or changes the parties shall first agree to possible addition or reduction in cost, the delivery date and such other terms and conditions occasioned by or resulting from such modification or change. Such agreement shall be effected either by way of exchange of letters duly signed by authorised representatives of the parties or by signed change order form or by minutes of meeting signed by authorised representatives of the parties, which shall constitute the necessary amendments to the contract. Possible increase or decrease in the contact price shall be calculated in accordance with unit prices. The cost of such additional jobs should be reasonably fixed with reference to the quoted price for such or similar items.

**(xii) Opening of the tender:** The Technical Bids will be opened by the tender committee duly constituted in the presence of bidders or their authorised representatives on

31.05.2018 @ 16.00 hours. Then the bids will be evaluated by the Technical Evaluation Committee which will decide the suitability of the technical bids as per our requirement and terms and conditions. Once the technical evaluation is completed, the price Bids of only those bidders who are found technically acceptable will be opened in the presence of Authorized Representatives of such bidder(s), if any on a date and at a venue to be intimated by IIT Tirupati to the short listed bidders.

**(xiii)** The bidder shall note that any unsolicited post-tender reduction by them would disqualify them from participating from the bidding and forfeit the security bid.

(xiv) Incomplete bids are liable for rejection.

**(xv) Prices:** The price should be quoted on FOR: IIT, Tirupati. The bid should consist of basic price, P&F charges, freight, unloading charges, Installation and commissioning charges and applicable taxes.

The total landed cost will be calculated from the information provided by the bidder in their price bids. The bid conforming to the lowest cost would then be considered for award of contract.

The custom duty if any applicable must be shown separately. It may be noted that IIT Tirupati is exempted from payment of custom duty and duty at concessional rate against duty exemption will be paid.

In case of import supply, the price should be quoted on EX-WORKS/FOB/CIP basis indicating the mode of shipment.

IIT Tirupati reserves the right to split and award item-wise contract to the lowest bidder.

**Offer validity:** The offer must be valid for 90 days from the closing date in the case of indigenous supply and 120 days in the case of import supply. If the validity of offers for acceptance is less than 90 days or 120 days, the same will not be considered.

**IIT Tirupati** reserves the full right to accept / reject any tender or all tenderers at any stage without assigning any reason.

Yours sincerely,

**Registrar, IIT Tirupati**

**Important Commercial terms and conditions:**

- a) The due date for the submission of the tender is **31.05.2018 at 15.30 hours**.
- b) **Late offer:** The offers received after the due date and time of closing will not be considered. The Institute shall not be responsible for the late receipt of Tender on account of Postal, Courier or any other delay.
- c) **Performance Bank Guarantee:** Performance Bank guarantee for 5% of Purchase order value should be produced in the form of B.G from the nationalised /scheduled Bank valid till the completion of warranty / guarantee period plus sixty days as claim period. Where-ever installation/commissioning is involved, the guarantee/warranty period shall be reckoned from the date of completion of installation/commission. Failure to render contracted service during the warranty/guarantee period by the contractor, the performance bank guarantee will be forfeited. No interest is payable on the performance Bank guarantee amount.
- d) **Inspection Clause:** All major mechanical equipment will be inspected by a team of IIT Tirupati at Supplier's premises and after clearance in the form of report, the items shall be despatched to IIT Tirupati. Readiness of equipment shall need to be intimated well in advance for our inspection formalities.
- e) **Delivery Schedule:** Please note that delivery is the essence of the contract. In case there is any deviation in the delivery schedule, liquidated damages clause will be levied for the delayed period of supply. Therefore, it should be ensured that all the ordered items should be supplied within 2 months from the date of receipt of Purchase Order on door delivery basis at our Institute as per Purchase order terms with securely and sufficiently packed by following standard packing procedure to withstand transit damages. In case of import supply, the item should be delivered at the cost of supplier to our institution. The installation and commissioning should be completed as specified in our important terms and conditions.
- f) **Extension of time:** If the completion of stores is delayed due to reason of force majeure such as acts of God, acts of public enemy, acts of Government, fires, floods, epidemics, quarantine restriction, strikes etc., the contractor shall give notice within 15 days to Institute in writing of his claim for an extension of time. The Institute on receipt of such notice after verification, if necessary, may agree to extend the Contract delivery date as may be reasonable but without prejudice to other terms and conditions of the contract.

**g) Training on operation and maintenance:**

The system supplied should be installed and commissioned by the manufacturer/dealer at IIT Tirupati, Venkatagiri Road, Yerpedu, Choittoor Dist. A.P by trained and experienced service engineers. The Training related to operation and maintenance of the equipment has to be imparted to two faculty members/ technical officers of IIT Tirupati for a minimum duration of 2 working days excluding travel. The expenses related to travel (to and fro) including local travel, stay, food and per diem and training have to be completely borne by the vendor. Training materials shall also be given by the manufacturer (preferably Softcopy).

**h) Liquidated damages:** If the Contractor fails to deliver the material within the time specified in the Contract or any extension thereof, the Institute shall recover from the Contractor as Liquidated Damages a sum of one-half of one per cent (0.5 per cent) of the Contract Price of the undelivered material for each calendar week of delay. The total liquidated damages shall not exceed ten per cent (10%) of the Contract price of the unit or units so delayed. Stores will be deemed to have been delivered only when all their component parts are also delivered.

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**i) Guarantee/Warranty:** The Contractor shall guarantee that the material supplied shall comply fully with the specifications laid down, for material, workmanship and performance after acceptance of the material for a period of three years. The tenderer should clearly mention in the bid the period of guarantee/warranty offered by him. If any defects are discovered therein or any defects therein found to have developed under proper use arising from faulty stores design or workmanship, the Contractor shall remedy / replace such defective items at his own cost.

The Bidder should clearly categorize the Basic/Standard features as well as optional features of the system in order to have a clear cost comparison. Essential spares if any for maintenance to be quoted separately. The bidder should ensure continued supply of spares throughout the useful life of the equipment.

1. **Insurance:** IIT Tirupati being a Central autonomous body under Ministry of HRD, Government of India, we will not insure our goods. However, to safe guard the ordered material from probable transit damage while in transportation the contractor may insure the goods at his risk and cost.
2. **Payment terms:** No Advance payment will be made for Indigenous purchase. Our normal payment terms are 100% within 30 days after receipt of complete supply at our site and acceptance. However in case of high value Purchase Orders, as a special case, payment of 90% of Order value will be made based on pre-inspection of material at supplier's site and also on receipt of goods at our site and clearance by inspection team. Balance 10% of PO value after completion all inspection and acceptance formalities. For making payment original tax invoice in triplicate, Delivery Challan's, material test certificate, pre-inspection of material at factory, guarantee/warrantee certificates must be sent along with material.

- a. In case of import supplies, our normal terms of payment are by Sight Draft. However, other terms of payment such as Letter of Credit also considered as agreed upon by opening LC for 100% in which case 90% payment will be released against proof of shipping documents and balance 10% after successful installation wherever the installation is involved/on receipt and acceptance of material at our site.
3. **Advance Payment:** No advance payment to indigenous supplies will be made. However in case of import goods, specific percentage of advance payment will be agreed upon for which, the Foreign Vendor has to submit a Bank Guarantee equal to the amount of advance payment and it should be routed through the Beneficiary Bank to the end user Bank. Otherwise, the Indian Agent of the foreign vendor has to submit a Bank Guarantee through a Nationalized Bank of India.
  - a. If an Indian agent is involved, the following documents must be enclosed:
  - b. Foreign principal's proforma invoice indicating the commission payable to the Indian Agent and nature of after-sales service to be rendered by the Indian Agent.
  - c. Copy of the agency agreement concluded with the foreign principal and the precise relationship between them and their mutual interest in the business.
  - d. Enlistment with DGS&D as Indian Agent of Foreign principals under the Compulsory Enlistment Scheme of Ministry of Finance.
4. **Agency Commission:** Agency commission, if any, will be paid to the Indian agents in Rupees on receipt of the equipment and after satisfactory installation. Agency Commission will not be paid in foreign currency under any circumstances. The details should be explicitly shown in Tender even in the case of 'Nil' commission. The tenderer should indicate the percentage of agency commission to be paid to the Indian agent. The foreign Principal should indicate about the percentage of payment and it should be included in the originally quoted basic price, if any.
5. **On-site erection and commissioning:** It is the responsibility of the Contractor to install and commission the equipment or machinery supplied by them within 20 days from the date of receipt of the item at the site of IIT Tirupati and demonstrate the performance of the system to the satisfaction of the users/concerned faculty members/committee in-charge at IIT Tirupati. In case the Contractor fails to carry out the erection as and when called upon to do so within the specified period by the Institute, the Institute shall have the right to get the erection work done through any source of his choice. In such an event, the Contractor shall be liable to bear any additional expenditure that the Institute is liable to incur towards erection.
6. **Do not quote the optional items or additional items unless otherwise mentioned in the tender documents / specifications.**

ARBITRATION CLAUSE: Arbitration in the event of any dispute or difference arising under these terms & conditions or any Condition contained in the Purchase Order or in connection with this



contract (except as to any matter the decision of which is specially provided for by these conditions), the same shall be referred to the sole arbitration of the Registrar, IIT, Tirupati or of some other person appointed by him and the dispute further processed in terms of the Arbitration & Conciliation Act ,1996. There will be no objection that the arbitrator is a Government Servant that he deal with matter which the Contract relates to or that in the course of his duties as Government Servant has expressed views on all or any of the matters in dispute or difference .The award of the arbitrator shall be final and binding on the parties of this Contract.

If the arbitrator is the Registrar, IIT, Tirupati

- i. In the event of his being transferred or vacating his office by resignation or otherwise , it shall be lawful for his successor in office either to proceed with the reference himself for to appoint another person as arbitrator, or
- ii. In the event of his being unwilling or unable to act for any reason, it shall be lawful for the Registrar, IIT, Tirupati to appoint another person as arbitrator.

If the arbitrator is a person appointed by the Registrar, IIT, Tirupati – In the event of his denying or neglecting or refusing to act, or resigning or being unable to act, for any reason, shall be lawful for the Registrar, IIT, Tirupati to proceed with the reference himself or to appoint another person as arbitrator in place of the outgoing arbitrator subject, as aforesaid , to the Arbitration & Conciliation Act ,1996, and the rules there-under and any statutory modifications thereof for the time being in force shall be deemed to apply to the arbitration proceeding under the clause. The Arbitrator shall have the power to extend with the consent of the purchaser and the contractor the time for making and publishing the award. The venue of Arbitration shall be the place as the purchaser in his absolute discretion may determine work under the Contract shall, if reasonably possible, continue during Arbitration Proceedings.

All amendments, time extension, clarifications etc., if any will be uploaded in the website only and will not be published in newspapers. Bidders should regularly visit the above website to keep themselves updated. No extension in the bid due date/ time shall be considered on account of delay in receipt of any document by mail.

- b) Acknowledgement:** It is hereby acknowledged that the tenderer has gone through all the conditions mentioned above and agrees to abide by them.

**SIGNATURE OF TENDERER  
ALONG WITH SEAL OF THE  
COMPANY WITH DATE**

**Specifications for fluid machines and IC engines experimental setups for  
mechanical engineering laboratory.**

SNo	Experimental setup	Quantity
1	Bomb Calorimeter	1
2	Single cylinder gasoline engine with computer control setup	1
3	Twin cylinder turbocharged Diesel with EGR and computer control setup	1
4	Pelton Turbine setup	1
5	Francis turbine setup	1
6	Propeller turbine setup	1
7	Centrifugal pump setup	1

**Detailed Specifications:**

**1) Bomb calorimeter**

The Bomb Calorimeter experimental setup should allow students to investigate the calorific value of both liquid and solid fuels. The calorimeter should have following features and specifications:

- A combustion calorimeter for determining gross calorific values of liquid and solid samples
- Should be table top, compact, integrated modular design for convenient operation
- Should come with oxygen bomb, oval bucket, oxygen filling connection, digital temperature measurement kit, ignition unit, bomb maintenance kit.
- Should come with LCD display for measurements
- Analysis time per sample: 15 to 30 minutes
- Energy measurement : up to 40 kJ/gm
- Temperature measurement: Digital thermometer with resolution 0.005°C or Better
- Measuring Accuracy: 0.1 % or Better
- Should have provision/interface for logging temperature data at user specified time intervals

Oxygen/gas filling and water filling may be manual, semi-automatic or automatic.

**2) Single cylinder gasoline engine with computer control**

A single cylinder port fuel injection petrol engine with open ECU for laboratory experiments coupled with eddy current dynamometer along with appropriate instruments for

- Load and speed measurements
- Volumetric air flow measurement at intake
- Gravimetric fuel flow measurement
- Crank angle encoder
- Manifold and combustion chamber pressure sensors for pressure time history with 1 CA resolution (From Kistler/AVL/PCB) including charge amplifier
- Temperature measurements of intake air, exhaust gas and lubricating oil

The setup should enable study of engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance.

Engine Type	Single cylinder, 4 stroke Petrol, Air cooled
Dynamometer Type:	Eddy current
Propeller shaft:	With universal joints
Air box :	M S fabricated with orifice meter and manometer
Fuel tank capacity:	≥15 lit with glass fuel metering column
Temperature indicator :	Digital, multi channel with selector switch
Temperature sensors:	Thermocouple, Type K
Digital Speed indicator	Non-contact type speed sensor
Load sensor	Load cell, type strain gauge, range 0-50 Kg
Cylinder pressure sensor including charge amplifier	Piezo type with low noise cable and maximum pressure range of > 300 bar Make: Kistler/AVL/PCB
Crank angle Sensor	Resolution 1 deg CA with TDC pulse
Fuel flow transmitter	Range 0-500 mm WC
Air flow transmitter	Pressure transmitter, Range (-) 250 mm WC
Data Acquisition system	NI based USB interface with ≥ 200 ks/s

All the sensors and equipment must be from reputed manufactures. Set up should come with suitable software for data logging and data analysis. **Accuracy of the sensors should be <0.1 % of full scale values.**

Entire setup should be mounted on a strong and firm base frame.

### 3) Computer controlled Twin cylinder Diesel engine with common rail injection and EGR

The standalone experimental setup should include two cylinder, four stroke, CRDI Diesel engine connected to eddy current type dynamometer for loading with computer control capability. It should be provided with necessary instruments for combustion pressure and crank-angle measurements. These signals should be interfaced to computer through engine indicator for P- $\theta$  and P-V diagrams.

It should support Interfacing of airflow, fuel flow, temperatures and load measurement. The set up should have stand-alone panel box consisting of air box, fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, fuel injection pressure sensor, cylinder pressure sensor and crank angle encoder, process indicator and engine indicator. The setup should also include portable exhaust gas analyser for CO, HC, CO<sub>2</sub>, O<sub>2</sub> and NO<sub>x</sub> measurement.

The setup should enable students study of engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio, heat balance and exhaust gas composition.

Engine Type	Two cylinder, four stroke CRDI Diesel engine, 0.9 L capacity, Water cooled, Compression ratio : 18.5, with Solenoid injectors and progressive EGR system
Dynamometer Type:	Eddy current, water cooled from reputed make
Propeller shaft:	With universal joints
Air box :	Corrosion free metal fabricated with orifice meter and manometer
Fuel tank capacity:	≥15 litres with glass fuel metering column
Temperature indicator :	Digital, multi-channel with selector switch
Temperature sensors:	Type RTD, PT100 and Thermocouple, Type K
Digital Speed indicator	Non-contact type speed sensor
Load sensor	Load cell, type strain gauge, range 0-50 Kg or better
Cylinder pressure sensor including charge amplifier	Piezoelectric type with low noise cable and maximum pressure range of 250 bar, linearity less than 0.3 % FSO, shock resistance greater than 1600 g. Make: Kistler/AVL/PCB
Crank angle Sensor	Resolution 1 deg CA with TDC pulse
Fuel flow transmitter	DP transmitter, Range 0-500 mm WC
Air flow transmitter	Pressure transmitter, Range (-) 250 mm WC
Data acquisition system	NI based USB interface with ≥ 200 ks/s
Portable exhaust gas analyser	Portable exhaust gas analyser for CO, HC, CO <sub>2</sub> , O <sub>2</sub> and NO <sub>x</sub> measurement Resolution: 1 ppm or better for HC and NO. 0.1 % or better for CO, CO <sub>2</sub> and O <sub>2</sub>

All the sensors and equipment must be from reputed manufactures. Set up should come with suitable software for data logging and data analysis. **Accuracy of the sensors should be <0.1 % of full scale values.**

Entire setup should be mounted on a strong and firm base frame.

#### **4) Pelton Turbine setup**

The Pelton Turbine setup should have a small scale table top Pelton turbine with a valve to regulate the flow. This standalone unit should allow determining the operation characteristics of this type of turbine, the hydraulic and mechanical efficiency curves, to obtain the hydraulic and mechanical power, etc.

The experimental setup should have following specifications and features

- The turbine should include a pelton runner with buckets, which can be clearly seen through the turbine's transparent casing.
- A pressure gauge/sensor at the turbine water inlet to measure intake pressure.
- An adjustable nozzle needle for setting different nozzle cross-sections
- Should include sensor to determine the torque on turbine shaft
- Non-contact type speed measurement instrument
- Flow meter to measure the water flow rate
- Should come with necessary mounting table along water supply tank and pump
- It should be small with maximum floor area < 1.5m X 1.5m
- Maximum sump capacity < 150 Litres
- Should have computer interface for control
- Should include software for data acquisition, visualisation and operation

#### **5) Francis turbine setup**

The standalone experimental unit should include a rotor, a distributor with adjustable guide vanes, a band brake for loading the turbine and housing with a transparent front panel. The transparent cover should enable observation of water flow, the rotor and the guide vanes during operation. Proving should be available to modify the angle of attack and thus the power of the rotor by adjusting the guide vanes.

This standalone unit should allow determining the operation characteristics of this type of turbine, the hydraulic and mechanical efficiency curves, to obtain the hydraulic and mechanical power, etc.

- Setup should include closed loop water supply unit
- Should have a transparent front panel for observing the operating area
- Adjustable guide vanes for setting different angles of attack ( min 15 stages)
- Should include sensor to determine the torque on turbine shaft
- Spring balances for determining the torque
- Pressure gauge or sensor at turbine inlet
- Non-contact type speed measurement instrument

- Flow rate measuring instruments
- Maximum Floor area < 1.5 m X 1.5 m
- Maximum sump capacity < 150 Litres
- Should have computer interface for control
- Should include software for data acquisition, visualisation and operation

## 6) Propeller turbine setup

This standalone unit should allow determining the operation characteristics of Propeller turbine, the hydraulic and mechanical efficiency curves, to obtain the hydraulic and mechanical power.

The standalone experimental setup should have

- A closed water circuit with submersible pump, throttle valve and tank
- Adjustable flow rate with throttle valve
- Loading the turbine by use of air-cooled eddy current brake/ magnetic brake unit
- Rotor with fixed blades
- Adjustable guide vanes for setting different angles of attack
- Non-contact speed measurement at the turbine shaft and force sensor at the brake for measuring the torque
- Should come with electronic sensors monitor process variables
- Digital display for pressures, temperature, flow rate, speed and torque
- Maximum Floor area < 1.5 m X 1.5 m
- Maximum sump capacity  $\leq$  350 Litres
- Should have computer interface for control
- Should include software for data acquisition, visualisation and operation

## 7) Centrifugal pump setup

A standalone, compact centrifugal pump should allow students investigation of pumps in series and parallel configuration determining the head, recording the pump characteristics, determining the hydraulic power.

The set up should have following feature/specifications:

- Should contain two identical centrifugal pumps and an in- take tank with overflow to ensure constant suction head in the tank.
- The setup should allow the pumps to work alone, in parallel or in series.
- It should have ball valves in the pipes allow easy switching between series and parallel operation
- Each pump should have an electronic Motor Drive to control its speed.
- Should include sensors for pump head pressure , suction, flow rate and water temperature
- Maximum flow rate: < 40LPM for each pump
- Maximum total head: < 150kPa for each pump

- Maximum speed of pump: <4000 rpm
- The setup should include mounting stand and water sump of sufficient capacity to run the experiments.
- Maximum Floor area < 1.5 m X 1.5 m
- Maximum sump capacity < 200 Litres
- Should be capable of being linked to a PC via suitable interface
- Should include software for data acquisition, visualisation and operation

**Annexure B – Compliance Statement of Technical Specifications**

S.No.	Item description (specification of Item)	Compliance whether “YES” or “NO”	If No, then specify deviations explicitly
01.			
02.			
03.			