

# NATIONAL INSTITUTE OF TECHNOLOGY

## TIRUCHIRAPPALLI – 15

Department of Electrical and Electronics Engineering

Web: [www.nitt.edu](http://www.nitt.edu)

Phone: 0431 - 2503261



# TENDER DOCUMENT

Tender Notification No.: NITT/F-NO: UG-MOD 001, 002 /PLAN 2013-14/EEE Dated: 04/02/14

- Name of the component : **Work Stations for the Electrical Machines Laboratory and Power Electronics Laboratory**
- Quantity required : **7 Nos.-Electrical Machines Laboratory  
5 Nos. - Power Electronics Laboratory**
- EMD Amount : **Rs. 7,50,000/-**
- Cost of the Tender Document : **Rs.1000/-**
- Delivery : **Within 6 months after the release of purchase order**
- Last Date of submission of Tender : **~~06/03/14 up to 2 pm~~ 18.03.2014 up to 3.00 PM.**  
(Date Extended)
- Address for submission of Tender : The Director,  
National Institute of Technology- Tiruchirappalli,  
Tiruchirappalli – 620015, Tamilnadu, India  
**Kind ATTN to: Dr.S.Senthil Kumar**  
**Assistant Professor, EEE department**  
Phone: 0431- 2503261  
Email:skumar@nitt.edu
- Date of opening of technical bid : **~~06/03/14 at 2.30pm~~ 18.03.2014 up to 3.30 PM.**  
(Date Extended)



**NATIONAL INSTITUTE OF TECHNOLOGY  
TIRUCHIRAPPALLI – 15**

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

**Tender Notification No.: NITT/F-NO: UG-MOD 001, 002/PLAN 2013-14/EEE Dated: 04/02/14**

**NOTICE INVITING TENDER**

The National Institute of Technology, Tiruchirappalli (NITT) is an autonomous body under MHRD, GOI, imparting Technical Education and engaged in Research Activities. It is proposed to procure the following component for the Departmental academic/research activities.

Sealed bids under **two bid system** are invited for the following component subject to the following terms and conditions, from the reputed manufacturers or their authorized dealers so as to reach this office on or before scheduled date and time. The technical cover will be opened on the same day in the presence of bidders or their authorized agents who may choose to be present.

Name of the component : **Workstations for the Electrical Machines Laboratory and Power Electronics Laboratory**

Quantity required : **7 Nos.-Electrical Machines Laboratory  
5 Nos.- Power Electronics Laboratory**

EMD : **Rs. 7,50,000/-**

Cost of the Tender Document : **Rs. 1000**

Time for completion of supply after placing purchase order : **Within 6 months**

Last Date of submission of Tender : **18/03/14**

Address for submission of Tender : The Director,  
National Institute of Technology-  
Tiruchirappalli,  
Tiruchirappalli – 620015, Tamilnadu,  
India  
**Kind ATTN to: Dr. S. Senthil Kumar**  
**Assistant Professor, EEE department**  
Phone: 0431- 2503261  
Email:[skumar@nitt.edu](mailto:skumar@nitt.edu)

**Place, Date and time of opening of bid :**

Date: **18.03.2014**

Time: **3:30pm**

Venue: **Central Stores, NITT**

**Note:** The Institute shall not be responsible for any postal delay about non-receipt / non delivery of the bids or due to wrong address. Further, corrigendum if any, with respect to this tender will be hosted only in the website <http://www.nitt.edu> Please visit the website regularly for any updates.

## BIDDER'S COPY

### INSTRUCTIONS TO BIDDERS

- This document set contains the following:
  - Terms and conditions of the Tender
  - Details of the Firm offering this Quote
  - Technical Compliance Form
  - Quotation form (Price Bid)
  - Currency Form (quoted on behalf of the foreign suppliers)
  - NIT-T's check list copy
- The bidder's copy is for your future records. Please fill in and return only NIT-T's copy.
- The bidder should give details of their technical soundness and provide list of customers of previous supply of similar items to Universities, Institutes or Government Departments/Undertakings/public sectors with contact details. The details of the agency/profile should be furnished along with the copy of all related documents.
- Read through the terms and conditions given and affix your signature and seal if you find them acceptable. Any deviations may be recorded. Read carefully list of specifications that we have enclosed.
- Fill in the questionnaire regarding the Firm.
- The downloaded documents '**Technical Compliance Form**' and '**Quotation Form (Price Bid)**' should be **TYPE WRITTEN USING CAPITAL LETTERS ONLY**. At the time of filling the "**Quotation Form (Price Bid)**" make sure that you have not missed anything. Specify the model number & specification for each item. The form should be filled item-wise. Do not leave blank fields. If you are not quoting for a specific item, you should specify "**NOT QUOTING**".
- Do not use** ambiguous terms like "**yes**", "**complied**" or "**available**". Specifically mention the matching specification of the product offered by you. Make sure that you have affixed your signature with date and seal on all the documents.  
Please send the tenders in a sealed envelope super-scribed as "**QUOTATIONS AGAINST TENDER NOTIFICATION NO: NITT/F-NO:UG-MOD 001,002/PLAN 2013-14/EEE**" so as to reach "The Director, National Institute of Technology, Tiruchirappalli - 620 015, India" on or before **18/03/14 at 3 pm along with a Softcopy of the Technical Compliance form (along with cover-2) and Quotation Forms (along with cover-3) in MS-Excel file format in a CD/DVD or USB drive.**
- Any clarifications maybe sought at least 10 days prior to the tender due date by email to [skumar@nitt.edu](mailto:skumar@nitt.edu) or by written request to "The Registrar, National Institute of Technology, Tiruchirappalli - 620 015, India"
- Pre-bid conference will be held on 19/02/14 at 2 pm.** All the interested bidders (or their representatives) are advised to attend the pre-bid conference. The scope of NIT-T will be informed during the pre-bid conference. The site survey can be carried out on all working days between 04/02/14-10/02/14 from 2pm to 5pm.
- Corrigendum if any, with respect to this tender will be hosted only in the website <http://www.nitt.edu> Please visit the website regularly for any updates.

Last Date for receipt of tender at NIT-T : **18/03/14 at 3pm**

Opening Date for technical bid : **18/03/14 at 3.30pm**

CHECKLIST TO BE FILLED IN BY BIDDER	
List of documents to be enclosed	Completed & Signed
1. Terms and Conditions form	YES / NO
2. Details of the Firm offering this Quote	YES / NO
3. NIT-T's Quotation form (Technical & Price Bid)	YES / NO
4. Currency Form(quoted on behalf of the foreign suppliers)	YES / NO
5. Other technical specifications & pamphlets	YES / NO
6.EMD and tender cost(as DD/FDR/Bank Guarantee) in a separate cover	YES / NO

- Note:** 1. "Cover" should contain the following:
- Form of "**Acceptance of Terms and Conditions**".
  - Form of "**Firm details**"
  - Pamphlets, if any (in a separate sealed cover)
  - Quotation Form (Technical, Price Bid and Currency Form)

**Please retain this page with you for your future reference.**

**SECTION: 1 – TWO BID TENDER**

**Cover 1: EMD and Tender cost**

(should be super-scribed as 'EMD and tender cost cover' duly indicating the Tender reference No. and the due date of opening)

Earnest Money Deposit (EMD) and tender cost are to be submitted by way of Demand Draft/FDR/Bank Guarantee drawn on any Nationalized bank in India in favor of "The Director, NIT, Trichy" payable at Trichy. The bids submitted without EMD or tender cost will be treated as non-responsive and will be rejected. EMD shall bear no interest.

**Cover 2: Technical Bid**

(should be super-scribed as 'Technical Bid' duly indicating the Tender reference No. and the due date of opening)

Should contain:

- a. Technical pamphlets
- b. Detailed technical specification
- c. Copy of license certificate for manufacture/supply of the item\*
- d. Income Tax PAN number & TIN number.\*
- e. Last three years balance sheet approved by the CA and the IT clearance certificate.\*
- f. Warranty period offered for the tendered item to be specified. If the warranty period is not conforming with the schedule of requirements given in section 3 of the Tender document, the bid is liable to be treated as non-responsive and will be rejected.
- g. Duly filled up technical questionnaire, if any
- h. Duly filled up deviation schedules to technical specifications, if any
- i. Copy of supply orders completed during the last three years

\* Appropriately pertaining to the country of origin.

**Cover 3: Price Bid**

(should be super-scribed as 'Price Bid' duly indicating the Tender reference No. and the due date of opening)

Should contain:

- a. Price bid as per the format in Section-4 of the tender document
- b. Break-up price as per the format in Annexure-A

**Note:**

- a. If the prices are revealed in cover 1 or in cover 2, the offer will be summarily rejected.
- b. Each Cover shall be sent in a double sealed cover. The inner covers (Cover 1, Cover 2 and Cover 3) should be sealed individually with the Sellers's distinctive seal and super-scribed with the tender reference No. and due date of opening. All inner covers shall be placed in a common outer cover which shall also be sealed with seller's distinctive seal and super-scribed with the tender reference No. and due date of opening.
- c. Mention "Kind Attention: [Dr.S.Senthil Kumar](#) and submit at the address given in the Notice Inviting Tender.
- d. Cover 1 & 2 will be opened on the scheduled date and time mentioned in the tender enquiry.

- e. Cover 3 of the technically and commercially suitable offers alone will be opened on a date which will be intimated to the qualified bidders.

**SECTION: 2 – TERMS AND CONDITIONS FORM**

---

**IMPORTANT: READ THE FOLLOWING TERMS AND CONDITIONS AND  
SIGN THE ACCEPTANCE CLAUSE FOLLOWING IT**

---

The offers should be addressed to “The Director, National Institute of Technology, Tiruchirappalli 620015, India” and should be sent in a sealed envelope super-scribed BID **AGAINST TENDER NOTIFICATION No.: NITT/F-NO:UG-MOD 001, 002/PLAN 2013-14/EEE** so as to reach us **on or before 18/03/14 at 3 pm**

1. Each offer should be sent in a sealed cover with the tender documents. Tenders received through email or FAX will not be considered. **Softcopy of the Technical Compliance form and Quotation Forms should be submitted along with the tender in MS-Excel file format in a CD/DVD or USB drive. However, if there is any dispute between Hard copy and Soft copy, Hard copy will be taken.**
2. The tenders will be opened on **18/03/14 at 3.30 pm** in the presence of the vendors present with authorization letter from the respective companies / firms. Suppliers intending to attend the tender opening should intimate us in advance.
3. Full technical specifications and pamphlets should be sent along with the tenders. **Offers without proper technical specifications will be rejected.**
4. The rate quoted should be on unit basis excluding Taxes. Taxes and other charges should be quoted separately, considering exemptions if any.
5. All offers should indicate unit price (excluding taxes and duties applicable), Taxes and other charges should be mentioned separately, if any. Additional charges for packing, forwarding, freight, insurance etc., if any, should be clearly mentioned. Clearance at Customs will be arranged by us.
6. NIT-T is eligible for concessional Customs & Excise duty under Government of India Notification No.51/96for Central Customs and 10/97 for Central Excise Duty vide Certificate No.TU/V/RG-CDE(183)/2011 dt.10.10.11. Currently the purchaser is paying 5% Basic Customs Duty, 2% Educational Cess on Basic Customs Duty, 1% Higher Education Cess on Educational Cess, and 4% Import Additional Duty. **This institute is exempted from payment of service tax as per Sl.no. 9 of Government notification No25/2012-ST dated 20<sup>th</sup> june, 2012.**The Institute is not authorized to issue C and D forms of Sales tax certificate.
7. In case the offered items are to be imported, the rates should be quoted in foreign currency on C.I.F. Chennai Airport basis, and it should include the Freight up to Chennai airport and the insurance cover should be up to National Institute of Technology, Tiruchirappalli. NIT-T shall pay Customs duty if any.
8. If the price quoted is in foreign currency and if the order value is more than US\$10,000 and requested by the bidder then 100% payment will be made through **Letter of Credit (LC) at sight on acceptance. The bank charges outside India should be borne by the Supplier / Beneficiary. Part shipment not allowed.**
9. If the price quoted is in Indian Rupees, then 100% payment will be made only after installation and commissioning. **No advance payment will be made.**
10. No revision of the price bid will be allowed once the price bids are opened. In case of foreign currency, the agency should mention the % of currency fluctuations they can bear.
11. No increase in price will be allowed after our firm orders are placed.
12. **Payment of excise duty and sales tax / VAT (on ultimate products)** as applicable on the closing date of tender will be to the supplier's / contractor's account. Any statutory variation (both plus and minus) in the rate of excise duty/sales tax/VAT after closing date of tender/revised price bid but before the expiry of the contractual delivery / completion period will be to the account of the office.

The bidder(s) should indicate, in their bid, the amount with exact rate of the Excise and Sales tax/VAT on ultimate finished product, as applicable at tendering stage, separately in the bid. In case the above information subsequently proves wrong, incorrect or misleading (a) this Institute will have no liability to reimburse the excess in the difference in rates of the item under which the duty/tax assessed finally (b) this Institute will have the right to recover the difference in case the rate of duty / tax finally assessed is on the lower side. Any increase in excise duty, sales tax / VAT during extended period of the contract / supply order will be to supplier's / contractor's account where such extension in delivery of the materials/completion of the project was on the request of supplier / contractor. However, any decrease in excise duty/sales tax/ VAT during extended period of the contract / supply order, will be to the account of this Institute.

13. **This institute is exempted from payment of service tax as per Sl.no. 9 of Government notification No25/2012-ST dated 20<sup>th</sup> june, 2012. The tenderer should verify the excise duty exemption certificates of this institution and service tax rules before submission of the Bid. It will be assumed on the submission of bid that excise duty exemption will be provided and no other conditions after the issue of purchase order will be accepted. No service tax will be paid by this institute.**
14. The warranty period should be clearly mentioned. The maintenance charges (AMC) under different schemes after the expiry of the warranty should also be mentioned.
15. Quotation should be from authorized dealer or distributor or reseller for each of the product quoted. An authorization letter should accompany the quote for each product quoted; otherwise it may lead to rejection.
16. The delivery period and other terms should be clearly mentioned.
17. **Eligibility:** Quotation from registered firms/company's / manufacturer under TNGST/CST / other statutory bodies alone will be considered. Any Manufacturer / Supplier / Dealer who has been declared ineligible by World Bank/Government of India shall not be eligible to participate in this bid. Any fraudulent practices including concealing of facts at the time of submission of bid and there after shall lead to disqualification. List of beneficiaries especially from Educational Institutions / R & D Institutions should also be enclosed with the quotations.
18. For those instruments Cost exceeding Rs. 5,00,000/- the company should have (i) Three similar works, each of value not less than 40% of the estimated cost put to tender, or (ii) Two similar works, each of value not less than 50% of the estimated cost, or (iii) One similar work of value not less than 80% of the estimated cost, all amounts rounded off to a convenient full figure, in the last 7 years ending on the last day of the month previous to the one in which the tenders are invited.
19. Complete user, technical and service documentation and spare parts catalogue are to be provided along with the supply of the item.
20. The vendors are informed that they should not call us over phone or contact us in person. All clarifications can be obtained through E-Mail/FAX/Post. Vendors shall not make attempts to establish unsolicited and un-authorized contact with us after the opening of the offers and prior to the notification of the award. Any attempt by any vendor to bring to bear extraneous pressures on us shall be sufficient reason to disqualify the vendor.
21. Delay / loss in postal transit or due to other reasons will not be NIT-T's responsibility.
22. NIT-Tiruchirappalli is not responsible for accidental opening of the covers that are not **properly super-scribed and sealed** before the time scheduled for opening.
23. The tender should be made only on the FORM which is available in our website, otherwise it shall lead to rejection. The FORM should be duly filled up (preferably **TYPE WRITTEN IN CAPITAL LETTERS**) and should clearly mention the features offered by the bidder against each specification.
24. Authorized signatory should sign on all the pages. Bids without authorized signatures or seal of the firm will be rejected.
25. The manufacturers of the quoted make of the product must be of National / International repute and having ISO /BIS certificate.
26. **Liquidated damages:** If the bidder/supplier, after accepting the Purchase Order, fails to deliver any or all of the Goods within the period specified in the Order, NIT-T shall, without

prejudice to its other remedies under the Rules of Purchase, proceed to cancel the order or agree to accept a delayed delivery on the condition of payment of liquidated damages by the bidder / supplier a sum equivalent to 0.50% of the total cost as indicated in the Purchase Order (which will be deemed as agreed price) for each week or part thereof of delay until actual delivery or performance is completed and such penal charges shall be limited to a maximum of 5% of the total cost. Once the maximum is reached NIT-T may proceed on its own to consider the termination / cancellation of the order.

27. **The vendors are informed that they should sign a stamp paper agreement with NIT Tiruchirappalli, for Warranty, AMC, etc. before placing the final purchase order as per our terms & conditions and 5% -10% of purchase order value in the form of bank guarantee towards performance security. The bank guarantee will be returned to the supplier after the successful completion of supply, installation, and the warranty period.**
28. During Comprehensive Annual Maintenance (CAMC) period, if any equipment/component is found to malfunction then the vendor shall arrange for repair/replacement of the same within 48 hours.
29. During CAMC, if any equipment/component is to be taken out by the vendor for repair /replacement purpose, the incidental cost (transportation/labor) shall be borne by vendor.
30. Failure to comply with all the terms and conditions mentioned herein would result in the tender being summarily rejected.
31. Vendors are informed that once the companies are shortlisted based on the technical specification, only then the price bids of the firms that meet NIT-T's Technical specification / requirements would be compared.
32. The order will be based on the actual requirement at the time of ordering, optional items may also be ordered based on the actual requirements at the time of ordering. Not quoting for this may result in disqualification.
33. NIT-T reserves the right to modify or alter the specifications after short listing of tenderers.
34. NIT-T reserves the right to change the order quantity or split the orders among multiple vendors without assigning any reason(s) whatsoever.
35. NIT-T reserves the right to reject any or all the tenders without assigning any reasons whatsoever.
36. NIT-T reserves the right to purchase decreased number of quantity of the item to be purchased.
37. The agencies should submit their rate as per the format given in Section 4 of the Notice Inviting Tender in this cover. All the pages of the bid should be signed affixing the seal. All corrections and overwriting should be initialed.
38. The tender will be acceptable only from the manufacturers or its authorized supplier.
39. The price bid shall be **only** in the format of price schedule given in Section 4. The contract form as per format given in section 5 shall be submitted. Incomplete or conditional tender will be rejected.
40. Details of quantity and the specifications are mentioned in Section 3 appended to this Notice Inviting Tender.
41. The item to be used is strictly according to the specifications and subject to test by the Institute/concerned authorities. It must be delivered and installed in good working condition.
42. The Contractor/Supplier shall have no claim to any payment of compensation or otherwise whatsoever, on account of any profit or advantage which he might have derived from the execution of the work/supply in full but could not derive in consequence of the foreclosure of the whole or part of the works.
43. In case of dispute, the matter will be subject to Tiruchirappalli, Tamil Nadu Jurisdiction only.

**Release of EMD:** The EMD will be released after receipt of performance security from successful bidder.

**Validity of bids:** The rate quote should be valid for a minimum of 120 days. No claim for escalation of rate will be considered after opening the Tender.

**Imports:** In case, goods are to be imported, the Indian agent should furnish authorization certificate by the principles abroad for submission of the bid in response to this Notice Inviting Tender.

**Clarification of Tender Document:** A prospective bidder requiring any clarification of the Tender document may communicate to the contact person given in this notice inviting tender.

**Amendment of tender document:** At any time prior to the last date of receipt of bids, Institute may for any reason, whether at its own initiative or in response to a clarification requested by prospective bidder, modify the Tender document by an amendment.

***The Institute may at its own discretion extend the last date for the receipt of bids.***

The bids shall be written in English language and any information printed in other language shall be accompanied by an English translation, in which case for the purpose of interpretation of the bid, the English translation shall govern.

The Institute reserves the right of accepting any bid other than the lowest or even rejecting all the bids without assigning any reasons therefore. The decision of the Institute Purchase Committee is final in all matters of tender and purchase.

**The bidder should give the following declaration while submitting the Tender.**

### **ACCEPTANCE**

We accept the above terms and conditions and shall comply with them strictly.

**NAME OF THE VENDOR:**

**ADDRESS :**

**Signature and seal**



**“DETAILS OF THE FIRM OFFERING THIS QUOTE”**  
**(Write or print or type in block letters)**

1. Name of the firm: \_\_\_\_\_
2. Date of incorporation: \_\_\_\_\_
2. Nature of the company (tick one): Government / Public / Private Company / Partnership / Proprietorship
3. Specify the number of years in this line of activity by the Company: ∴
4. Quantity of sales in the last three years for the “.....” (same model that you have quoted):

2010-2011	2011-2012	2012-2013

5. Turnover in the last three years (Lakh Indian Rupees):

2010-2011	2011-2012	2012-2013

6. Provide the postal address, telephone & fax numbers, and email address of the nearest service center.
7. Number of service engineers in the above location trained on the product quoted along with their educational qualification, certification and designation (applicable only for instruments):
8. Assured response time for service calls in hours:
9. Delivery period from the date an official purchase order placed (in weeks):
10. Enclose the list of customers to whom you have supplied “.....” during the last 3 years ending 31/03/2013 with full postal address and name of the contact person with phone, FAX numbers, and E-Mail id. Certificate regarding satisfactory performance of the “.....” from the minimum three end users should be furnished.
11. Are you the authorized dealer or distributor or reseller for the products quoted?
12. Have you supplied “.....” to National Institute of Technology, Tiruchirappalli in the last 3 years? If yes, specify the quantity supplied in the last 3 years and last PO reference:
13. Was there any elapse or delay in supplying the goods ordered or any service related issue during the warranty period for the products ordered by NIT-T with your firm? If yes, provide details.
14. On Manufacturer’s Side to whom NITT have to contact in case of delayed in supply and other issues committed by the authorized dealer / distributor / reseller :

Contact Person Name : Address : E-mail ID :	Telephone / Cell Phone :
---	--------------------------

**DECLARATION**

I/we have not tampered/modified the tender forms in any manner. In case, if the same is found to be tampered/modified, I/we understand that my/our tender will be summarily rejected and full Earnest Money Deposit (EMD) will be forfeited and I/we am/are liable to be banned from doing business with NIT, Trichy and /or prosecuted.

**Signature of the Bidder** : .....

**Name and Designation** : .....

**Business Address** : .....

.....

.....

**Place :**

**Date :**

**Seal of the Bidder's Firm**

**SECTION: 3 – SCHEDULE OF REQUIREMENTS, SPECIFICATIONS AND ALLIED DETAILS**

**1) Specifications of Workstations for the Electrical Machines Laboratory and Power Electronics Laboratory**

Name of the Component to be procured: **Workstations for the Electrical Machines Laboratory and Power Electronics Laboratory**

Specifications : **Refer to Annexure B**

Quantity : **Refer to Annexure B**

Any other details/requirement: **Refer to Annexure B**

Warranty period required (years): **5 years**

Delivery schedule expected after release of purchase order (in weeks): **25 weeks**

EMD (in Rupees): **Rs.7,50,000/-**

Performance Security to be given by the successful bidder after release of purchase order (in Rupees) : **5%** of the total order cost



(Note: All columns should be filled. No column should be left blank. If any column is not filled-in properly or left empty then the bid will be rejected.)

**SECTION: 5 – CONTRACT FORM**

---

**To be provided by the bidder in their business letter head**

---

[Name of the Supplier's Firm] hereby abide to deliver, install and commission the .....by the schedule mentioned in the Section 3 of the Tender document for the items if the purchase order is awarded.

The item(s) will be supplied conforming to the specifications stated in the tender document without any defect and deviations.

Warranty will be given for the period mentioned in the tender document and service will be rendered to the satisfaction of NIT, Tiruchirappalli during this period.

**Signature of the Bidder** : .....

**Name and Designation** : .....

**Business Address** : .....

**Place :**

**Date :**

**Seal of the Bidder's Firm**

**SECTION: 6 – ELIGIBILITY CRITERIA**

**Bidders who fulfill the following criteria shall only be considered as eligible bidders. Those who do not fulfill any of the following criteria/whose bids do not contain the relevant document proof shall be considered as ineligible.**

<b>ELIGIBILITY CRITERIA</b>		
<b>Sl. No</b>	<b>Description</b>	<b>Vendor to specify details</b>
1	The vendor shall have a turnover of Rs.50 Crores minimum, for a consecutive period of 3 years. Balance sheet and other relevant documents shall be provided to support this qualification.	
2	Vendor should have executed similar Modern Electric Machines and Power Electronics Lab Projects on a Total Turn Key basis with complete ownership in India in the last four years period and proof to that effect shall be provided.	
3	Vendor should have supplied similar modern lab equipments to at least two government funded educational institutions. Required evidence shall be provided along with offer.	
4	Vendor shall be a reputed manufacturer of the power electronic drives/ machines or their authorized representative and proof to that effect shall be provided.	
5	Vendor shall be required to present their capabilities to the technical committee, if applicable.	
6	Vendor shall possess ISO 9000 certification for Quality System implementation. Required evidence shall be provided along with offer.	
7	All the equipment and components in the work stations for Electrical Machines Laboratory and Power Electronics Laboratory should be quoted as a single item. Partial quotes are not accepted.	
8	Similar components/equipments should have same make for compatibility. For example all rotating electrical machines shall be of the same (reputed) make and all power electronic drives should be of the same (reputed) make. These should be of industrial grade (quality).	

**SECTION 7: Scope of Work of Vendor**

<b>Sl.No</b>	<b>Item description</b>	<b>Vendor to specify Details</b>
1.1	Site survey, Layout Planning, Design, Development and Supply of the entire system for the workstations in both Electrical Machines Laboratory and Power Electronics Laboratory (As per Annexure B) with associated wiring from the distribution box to the workstations.	
1.2	The data acquisition system and software should be interfaced with the system by the vendor. The data acquisition system and software will be supplied by NIT-Tiruchirappalli.	
1.3	Details of planning and smooth execution of the project.	
1.4	Testing, Installation & Commissioning of the complete system.	
1.5	Training of the staff deputed by National Institute of Technology, Tiruchirappalli.	
1.6	Providing a comprehensive warranty for five years from the date of successful commissioning.	
1.7	Break down maintenance during the warranty period. The cost of spare required has to be met by the vendor.	
1.8	The vendor has to give the necessary layout for making the concrete beds by NIT-T	
1.9	The vendor has to depute one on-site skilled technician (with at least diploma qualification) for maintaining the system for five years after the successful commissioning of the entire system.	

**NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPALLI**

**Annexure-A**

**MODEL PRICE BID FORMAT FOR INDIAN BIDDERS**

Tender No. & Date:

Bidder's Offer No. & Date:

S. No.	Description of item	Unit (SET /No)	QTY	Rate /Qty in Rs. (excluding of all taxes)	ED in %	VAT/ CST In %	Service Tax in %	Total Value in Rs. (inclusive of all taxes)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	<b>Supply portion</b> (The price indicated shall be exclusive of all accessories, spares etc. as given in the scope of supply)							
2	Other accessories /spares etc as given in scope of supply (Individual item-wise break-up price shall be attached as an Annexure to this price bid format.)							
3	Installation & Commissioning (extra, if any)							
4	Packing & Forwarding charges (extra, if any)							
5	FOR Dispatching station value in Rs.							
6	Freight & Transit insurance charges, extra, if any							
7	<b>Total cost to be paid by NITT</b>							
* 8	Value of Comprehensive Annual Maintenance Contract (for five years)							
* 9	Cost of deputing one onsite skilled technician for five years							

**Signature & Seal of Vendor**

**Note: The price bid should be submitted only as per the above format. No row shall be left blank. Please indicate NA, in case the item is "Not Applicable". If this format is not used or any column is left blank, then the bid will be rejected.**

**\*The contract for the item no: 7 and 8 will be placed with the vendor to whom the tender is awarded. The payment of these items will be made half yearly on completion of the above said period. The lowest price will be calculated by including (item 8) CAMC.**



## ANNEXURE-B

### 1) **Specifications for workstations to the Electrical Machines Laboratory and Power Electronics Laboratory**

It is planned to set up workstations for Electrical Machines Laboratory and Power Electronics Laboratory of National Institute of Technology, Tiruchirappalli.

#### 1.1) **Design of layout of workstations (scope of vendor)**

- a) **For electrical machines laboratory:** The space (35m x 6.7m) earmarked in the electrical machines laboratory in the institute shall be utilised by the vendor for mounting the **7** new installations in an optimal manner to suit the specifications in the tender document (in section 1.2a of this Annexure).
- b) **For Power Electronics laboratory:** The space (11.6m x 6.7m) earmarked in the Power Electronics laboratory in the institute shall be utilised by the vendor for mounting the **5** new installations in an optimal manner to suit the specifications in the tender document (in section 1.2b of this Annexure).

**The final design of layout of workstations (both 1.1a and 1.1b) shall have the approval of NITT prior to preparation of concrete beds by NITT.**

#### 1.2) **Description of one workstation:**

##### a) **For electrical machines laboratory:**

The composition of a single workstation for Electrical Machines Laboratory is shown in Fig. 1. Each workstation should contain two **Composite Machine Benches (CMB)** known as CMB-A and CMB-B, each of which in turn has two parts, termed part1 and part2. The Composite Machine Bench consists of electrical machines, a variable output isolation transformer, a load bank, associated instrumentation facilities, a laptop/computer (not in the scope of supply of vendor), a wooden worktable, relevant switchgear and connection wires. The grouping of the machines as part1 and part2 are detailed in Fig.1 to Fig.5.

**Seven workstations** should be set up in the electrical machines laboratory.

##### b) **For Power Electronics Laboratory:**

The composition of a single workstation for Power Electronics Laboratory is shown in Fig.6. The arrangement of the workstation in this case is similar to that of Electrical Machines Laboratory (specified in 1.2a). The workstation in the Power Electronics Laboratory should

have all the elements as in Electrical Machine laboratory (specified in 1.2a). In addition, it should contain two AC drives and two DC Drives.

**Five workstations** should be set up in the power electronics laboratory.

### **1.3) Arrangement of the CMBs in one workstation (applicable to both 1.2a and 1.2b)**

Each workstation should accommodate:

- i. Composite Machine Bench A: Part1 consists of the machine layout shown in Fig. 2.
- ii. Composite Machine Bench A: Part2 consists of two single phase transformers as shown in Fig.3
- iii. Composite Machine Bench B: Part1 consists of the machine layout shown in Fig. 4
- iv. Composite Machine Bench B: Part2 consists of a single phase induction machine coupled with a DC machine shown in Fig. 5.

This arrangement is common for both Electrical Machines laboratory (1.2a) and Power Electronics laboratory (1.2b) as shown in Fig.1 and Fig.6. The complete instrumentation at the workstation shall be placed alongside, with adequate clearance to facilitate the experimental activities of the students. The wiring for various power supply connections to the machines in each work station shall be designed and implemented by the vendor. The allocated space for each workstation is 3000mmx1650mm approximately for both sections 1.2a and 1.2b.

### **1.4) Quantity**

- A. Electrical Machines Laboratory: **7 work stations**
- B. Power Electronics Laboratory : **5 Work stations**

### **2) Technical specifications**

#### **2.1) Part1 of Composite Machine Bench A and B**

Part1 of each composite machine bench consists of one three-phase induction machine, two identical dc machines and one synchronous machine. The machines shall be laid out in one single row and coupled in the manner shown in Fig.2 and Fig.4.

The three-phase induction machine is placed at one end. It is coupled through a love-joy coupling to a dc machine having shaft extension on both sides. The other side of the dc machine is coupled to another dc machine having double side shaft extension through an electromagnetic clutch. This second dc machine is further coupled to a synchronous machine through a love-joy coupling. The two dc machines must be identical units.

The electromagnetic clutch should be powered from the workbench. All these machines are to be mounted on a common frame as depicted in Fig. 2 and Fig. 4. This frame is to be fixed to the concrete bed. The overall assembly is to be restricted to the dimensions shown in Fig. 2 and Fig. 4. The machine set should also have two slotted discs mounted on the shaft for speed sensing. The positions are shown in Fig. 2 and Fig. 4. A suitable pickup (if optical sensor is used casing must be IP 54, not shown in Fig. 2 and Fig. 4) shall be used to sense the speed from the slotted disc. This should be used to provide speed indication on the workbench. A panel meter shall be used on the workbench with a switch to select the input from either of the two pickups. Both pulse and dc outputs must be provided.

The concrete bed and machine assembly should also have a facility to lock the rotor of the induction machine while doing tests. The maximum speed which the set must withstand is 2500 rpm.

## **2.2) Part2 of Composite Machine Bench A**

It consists of two single phase transformers mounted on a common frame as shown in Fig.3.

## **2.3) Part2 of Composite Machine Bench B**

The single phase induction machine coupled with DC machine is shown in Fig.5. The coupled set would also have slotted disc mounted on the shaft for speed sensing. A suitable pickup (if optical sensor is used casing must be IP 54, not shown in Fig.5) shall be used to sense the speed from the slotted disc. This would be used to provide speed indication on the workbench. A panel meter shall be used on the workbench with a switch to select the input from either of the two pickups.

### 3) Specifications of Individual Machines / components

#### 3.1) THREE-PHASE INDUCTION MACHINE

**QUANTITY : 24 UNITS (7x2+5x2)\***

The induction machine is specified as follows.

Power Rating	:	1 kW
Stator Voltage	:	415V $\pm$ 10%
Rotor	:	Squirrel cage, with bar skew of one rotor slot width
Frequency	:	50Hz $\pm$ 5%
Poles	:	4, slip to be in range (4-6)%
Power factor	:	Greater than or equal to 0.8 @ full Load
Efficiency	:	Greater than or equal to 80% @ full load
Insulation	:	Class F with temperature rise limited to Class B
Protection	:	IP55
Enclosure	:	TEFC
Duty Class	:	S1
Standards for testing	:	Applicable IS
Termination	:	Terminal box, all six terminals of stator winding

(3- phase and two ends for each) need to be brought out.

Provision is to be made to operate the machine as star/delta on the stator.

Efficiency shall be as given above. Deviation shall not be accepted w.r.to IS guidelines

\*7 workstations for Electrical Machines Laboratory and 5 workstations for Power Electronics Laboratory.

### 3.2) SINGLE-PHASE INDUCTION MACHINE

**QUANTITY : 12 UNITS (7 x 1+ 5 x 1)**

The induction machine is specified as follows.

Power Rating	:	1 kW
Stator Voltage	:	230±10% V
Rotor	:	Squirrel cage, with bar skew of one rotor slot width
Frequency	:	50 ±5% Hz
Poles	:	4, slip to be in range ( 4-6)%
Power factor	:	Greater than or equal to 0.8(@ full Load
Efficiency	:	Greater than or equal to 80% @ full load
Starting Type	:	Capacitor Start Capacitor Run
Insulation	:	Class F with temperature rise limited to Class B
Protection	:	IP55
Enclosure	:	TEFC
Duty Class	:	S1
Standards for testing	:	Applicable IS
Termination	:	Terminal box, terminals for Auxiliary winding and the Capacitor to be brought out.

DC machine is to be set up as the load for the single phase induction machine.

Efficiency shall be as given above. Deviation shall not be accepted w.r.to IS guidelines

### 3.3) DC MACHINE

**QUANTITY : 50 UNITS (7x5+5x3)**

The two DC Machines in the set are to be identical. Their specifications are as follows.

Power Rating	:	1.1kW
Speed(rpm)	:	1500
Type	:	Shunt/Separately Excited
Armature Voltage	:	220V
Field voltage	:	220V
Maximum Field Current	:	not more than 0.8A
Poles	:	4 pole, laminated
Full load Efficiency	:	Equal to or better than 70%
Insulation	:	Class F with temperature rise limited to Class B
Protection	:	IP23
Enclosure	:	TEFC
Standards	:	Applicable IS
No load voltage ripple factor	:	lesser than 1% at rated speed
Duty class	:	S1
Termination	:	Terminal box, all 4 winding terminals (2 field + 2 armature) brought out

Efficiency shall be as given above. Deviation shall not be accepted w.r.to IS guidelines

### 3.4) SYNCHRONOUS MACHINE :

**QUANTITY : 24 UNITS (7x2+5x2)**

The specifications of the synchronous machine are as follows.

Power Rating	:	1.5 kVA, 0.8 pf Lag
Type	:	Salient Pole/ cylindrical rotor*.
Field excitation	:	220 V, through slip rings
No. of poles	:	4
Frequency	:	50±5%Hz
Stator voltage	:	415±10% V, 3 phase
Field current	:	0.8 A at 0.8 pf lag
Max field current	:	1 A
Efficiency	:	Equal to or better than 80%
Short Circuit current	:	Greater than 3 times full load current
Duty Class	:	S1
Damper winding	:	Required
Insulation	:	Class F with temperature rise limited to Class B
Protection	:	IP23
Enclosure	:	TEFC
Termination	:	Terminal box, six stator winding terminals & two field winding terminals

Stator phase voltage waveform -3rd harmonic : < 3% of fundamental THD: < than 4%,  
slot harmonics <0.1% of fundamental

\*The vendor shall supply 12 cylindrical rotor machines and 12 salient pole rotor machines.

Efficiency shall be as given above. Deviation shall not be accepted w.r.to IS guidelines.

### 3.5) THREE-PHASE TRANSFORMER

**QUANTITY : 24 UNITS (7x2+5x2)**

The transformer should be of variable output (autotransformer-like) isolation type. The secondary shall be wound over the primary with suitable insulation between them. The secondary output shall be tapped by means of a brush arm moving on it. Brushes for the three phase windings shall be made to move in tandem by means of a common arm. The general overall size shall not exceed 600 mm (height) X 300 mm (width) X 300 mm (depth).

The mechanical arrangement shall be such that the rotating shaft (at the user end) shall be horizontal.

Power Rating	:	1.5 kVA
Type	:	Dry type, isolation auto- transformer with continuously variable output by means of tapping.
Input Voltage	:	3 phase, 4 wire, 415±10% V
Output Voltage	:	3 phase, 4 wire, 0-440V
Frequency	:	50±5%Hz
Insulation	:	Class F with temperature rise limited to Class B
Winding Connections	:	Star/Star
Terminal	:	Input: RYBN terminals marked Output: RYBN terminals marked
Termination	:	Banana Socket, 10A rated
Temperature rise	:	Within Class B limits
Cooling	:	Natural Air Cooled
Protection	:	IP23
Enclosure	:	TEFC



### 3.6) SINGLE-PHASE TRANSFORMER

**QUANTITY** :14 UNITS (7x2 + 5x2)

The single-phase transformer is specified as follows.

Power Rating	:	1.5 kVA
Type	:	Dry type.
Primary Voltage	:	230±10% V
Secondary Voltage	:	50%:86%:100% of nominal secondary voltage
Frequency	:	50±5% Hz
Protection	:	IP23
Enclosure	:	TEFC
Termination	:	Banana Socket, 10A rated
Temperature rise	:	Within Class B limits
Cooling	:	Natural Air Cooled

### 3.7) ELECTROMAGNETIC CLUTCH

**QUANTITY** :24 UNITS (7x2 + 5x2)

Type	:	Dry type
Speed	:	2500 rpm (max)
Torque	:	20Nm
DC voltage	:	24V
Engaging Current	:	2A
Cooling	:	Natural Air Cooled

### 3.8) SLOTTED DISC

**QUANTITY** : **48 UNITS (7x4 + 5x4)**

Thickness	:	2mm
No of Slots	:	120
Material	:	MS, powder coated type
Colour	:	Same as machine body
Outer Diameter	:	95mm

### 3.9) LOAD BOX

**QUANTITY** : **24 UNITS (7x2 + 5x2)**

The load box is a three phase resistor bank. The resistance in each phase is variable by a switch, ganged together for simultaneous variation in each phase. The general overall size shall not exceed 600 mm (height) X 300 mm (width) X 300 mm (depth).

Element Type	:	Non Inductively Wound resistors
Phase	:	3 Phases
Frequency	:	50±5%Hz
Power Rating	:	1.5kW
Voltage	:	415±10%V
No of steps in each phase	:	Five
Terminations	:	Banana socket, 10A rated
Cooling	:	Forced air with fan drawing ambient air from outside

The load box shall have six terminations, two for each phase. The wiring must be suitably heat resistant and done such that between each pair of terminals, the effective resistance must vary in five steps by the action of the switch. The maximum power dissipated by the box when connected in three phase star manner shall be 1.5 kW. The ganged switch shall also have one position such that no resistance is connected in any phase (open circuit). The ganged switch shall be guaranteed for at least 16000 operations.

The terminals and the selector switch of the load box shall be brought on to the terminal area of the workbench.

### **3.10) INSTRUMENTATION PANELS**

There shall be two instrumentation panels per workstation, one for CMB A, CMB B as shown in Fig.1 and Fig 6. Each of these panels shall have provision to make the following types of measurements — voltage (TRMS), current (TRMS), three phase power and single phase power. The bench shall also have a speed indication in rpm (derived from the pickups on the machine set). There shall be a provision to allocate a wooden worktable (850mm\*1500mm) along with the instrumentation panel to carry out the experimentation. The worktable top should be made with waterproof, termite resistant plywood with a laminated smooth surface. The frame may be of steel for the table. The design of the table shall be such that the 3-phase transformers, load boxes and drive cabinet can be easily accommodated in the table. There shall also be a provision of a draw-out so as to house the computer keyboard and mouse. The structure of the worktable is shown in Fig.7.

A storage area should be provided on the top of the worktable as shown in Fig.7 which should be made of the same material as mentioned above.

#### **A. Voltage and Current Measurements**

**QUANTITY : 24x5 Units for voltage and 24x5 Units for current**

The vendor shall provide current measurement through a Hall Effect sensor. The sensor used shall be LEM LA-25NP or equivalent subjected to the approval of purchase committee. Each sensor shall be equipped with suitable signal conditioning circuitry to provide an output limited to  $\pm 10$  V. Five such current sensors shall be housed in one powder coated metal box. This box shall have terminals that provide input to the hall sensors and output terminals to

take output from the hall sensors. The outputs from all the five hall current sensors shall have a common ground. The box shall also have a power supply input terminal block accepting suitable power supply to be used for the output side circuitry of the hall sensors. This box is referred to as the 'HC box'.

The vendor shall provide voltage measurement through a Hall Effect sensor. The sensor used shall be LEM LV25-800 or equivalent subjected to the approval of purchase committee. Each sensor shall be equipped with suitable signal conditioning circuitry to provide an output limited to  $\pm 10$  V. Five such voltage sensors shall be housed in one powder coated metal box. This box shall have terminals that provide input to the hall sensors and output terminals to take output from the hall sensors. The outputs from all the five hall voltage sensors shall have a common ground. The box shall also have a power supply input terminal block accepting suitable power supply to be used for the output side circuitry of the hall sensors. This box is referred to as the 'HV box'.

Power supply to the two hall sensor boxes shall be provided through an isolated supply derived from 230 V, 50 Hz ac mains. Appropriate circuitry deriving this supply shall be provided in a powder coated metal box with suitable input and output terminations, such that the outputs can be wired to the HC and HV boxes. This box shall be called as 'HPS box'.

The HC, HV and HPS boxes shall be housed in a separate cabinet placed below the table. This cabinet would also house the ac and dc drives for the work stations in the power electronics laboratory. The boxes shall also carry the label HC, HV and HPS respectively. The cabinet is more fully described in the section on Drives.

The measurement inputs and outputs from HC and HV boxes shall be terminated on the measurement area of the table. The measurement input points shall be terminated on banana plug sockets, two for each sensor. The banana sockets shall be rated for 10 A capacities. The measurement outputs shall be terminated on BNC connectors, one for each sensor. The input and outputs for each sensor shall be grouped together to allow easy identification, but spaced out properly to allow easy access for connection.

Two 3 1/2 digit LED panel meters shall be provided on the panel to measure the current sensor outputs. The meter shall not have an independent current transducer, but will work from the hall sensor outputs. There shall be a selection mechanism to allow selection of the

hall sensor outputs to the meter. The hall sensors together with the meter shall act as a system such that the meter reads the true rms value of the current in the power circuit. The meters shall accept the hall sensor signals through selector switches. One meter shall receive signals from two sensors, while the other meter shall receive signals from the other three sensors. The selector switches shall be guaranteed for at least 16000 operations.

A similar arrangement shall be provided for the voltage sensor outputs as well.

All terminals shall be red (+) and black (-) pairs for voltage connections and blue (current in) and black (current out) for current connections.

### **B. Power Measurement**

**QUANTITY : 2x2x12 Units for Single-Phase Power and 2x2x12 Units for Three-Phase Power**

The cabinet housing the HC, HV and HPS boxes shall also house two three-phase power transducers and two single-phase power transducers. They shall be powered from the HPS box.

The input to these power transducers and the outputs shall be terminated on the measurement area of the workbench. The inputs shall be of banana socket type (10 A rating). The outputs, limited to  $\pm 10$  V, shall be terminated on BNC terminations. These outputs shall also be routed to suitable digital LED panel meters (3½ digit) so as to indicate the actual power. There shall be one meter for three-phase transducer outputs and one for single-phase. Their inputs shall be selectable using a selector switch (one for three-phase, one for single-phase).

### **C. Speed Measurement**

**QUANTITY : 5x12Units**

The measurement area shall also have a digital LED panel meter (3½ digit) to indicate the speed in rpm of the shaft from the pickups on the machine set. The panel meter shall directly accept pulses from the pickup and indicate speed.

All panel meters shall have an associated legend marking to identify the readout type

### 3.11) DRIVES (relevant for power electronics laboratory only)

The vendor shall supply drives for the work stations in the power electronics laboratory. These drives shall be housed in a cabinet already referred to above in the section on current and voltage measurements. The size of the cabinet shall not exceed 700 mm (width) X 600 mm (height) X 550 mm (depth). The cabinet shall be made of MS and have a proper earth connection. All power metal boxes within shall also have a suitably designed earth connection point.

#### 3.11.1) AC Drives

**QUANTITY :10 Units**

The specifications of the ac drive (meant to drive the induction motor in the machine set) unit are as follows. The vendor shall specify the time duration the machine can be operated on full load under inverter supply at various speeds.

Input	:	415V $\pm$ 10%,50 $\pm$ 5%Hz,3 wire
Output	:	0-415V, Variable Frequency ( range: 0 to 50Hz)
Rated Power	:	1kW
Control Type	:	V/f and Vector Control
Input Section	:	Diode Bridge
Output Section	:	Four Quadrant Inverter
Braking	:	Dynamic Braking Resistor Should be provided
Speed Feedback	:	DC Voltage
Speed Reference	:	Adjustable in control panel (10V for maximum speed)
Controller Gains	:	Adjustable by the user

The drive shall also have facility to be run as a multiple motor and drive system accepting reference command on a common communication bus for future use. The drive shall have the capability to use all popular communication protocols – CANBUS / PROFIBUS / Devicenet / MODBUS

### 3.11.2) DC DRIVES

**QUANTITY : 10 Units**

The specifications of the dc drive (meant to drive the dc motor in the machine set) unit are as follows. The vendor shall specify the time duration the machine can be operated on full load under drive operation at various speeds.

Input Voltage	:	415V±10%, 50±5%Hz,3 wire
Output Voltage	:	0 to 220V
Output Power	:	1.1kW
Drive Type	:	Dual Converter
Braking	:	Regenerative
Speed Feedback	:	DC Voltage
Speed Reference	:	Adjustable in control panel (10V for maximum speed)
Controller Gains	:	Adjustable by the user

The drive shall also have facility to be run as a multiple motor and drive system accepting reference command on a common communication bus for future use. The drive shall have the capability to use all popular communication protocols – CANBUS / PROFIBUS / Devicenet / MODBUS.

### 3.12) CABLES

Cables of 10 A capacity should be supplied which must be terminated on both ends with banana plugs of 10 A capacity. The number and length of these cables shall be such that all tests mentioned in the section 5 shall be feasible, with 10% more as spare (on a per CMB basis).

In addition, signal cables terminated with BNC connectors on either side shall be supplied. These will be 20 in number per CMB.

#### **4) Scope of the Institute**

The Institute specifies the following as the acceptable brands.

##### **Acceptable Brands**

1. The acceptable brands for the electrical machines are:

- Siemens
- ABB
- General Electric Co.
- Baldor
- Reliance
- Kirloskar Electric Co.
- Integrated Electric Co.
- Terco
- Crompton Greaves

2. The acceptable brands for the electric drives are:

- Siemens
- ABB
- General Electric Co.
- Rockwell Automation

3. Both the DC and AC drives shall be from the same manufacturer.

#### **5) Inspection and Acceptance**

The bidder who have met all the conditions and approved by the selection committee shall setup one complete and functional prototype unit as per the specifications herein within three weeks of intimation.

The vendor shall arrange for inspection of this prototype at their premises by an NIT –T team. The vendor must give the test reports of all the machines in the unit confirming the specification. In addition, the following tests shall be done in the presence of the NIT-T team

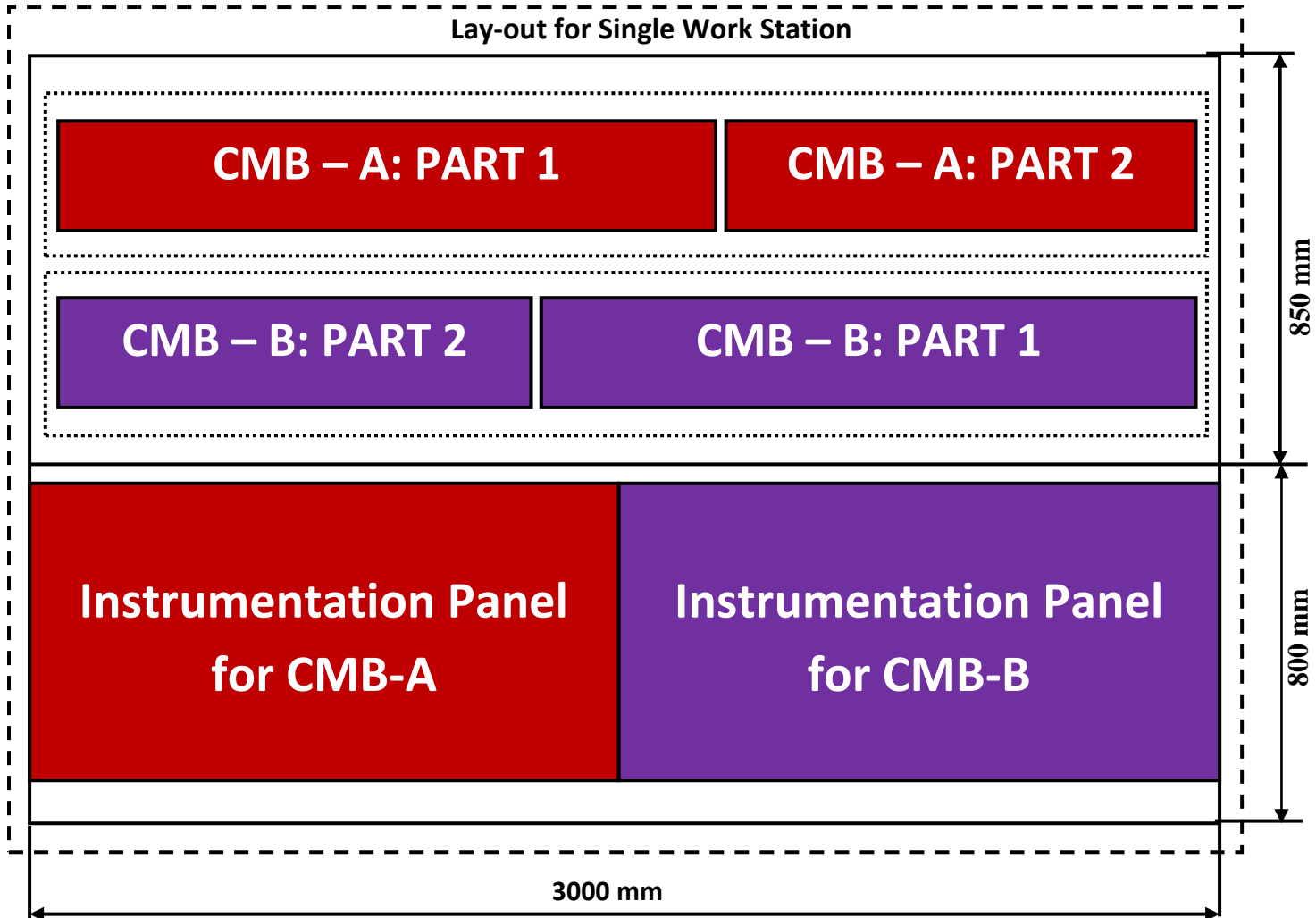


to verify the working of the overall setup. The necessary set up for experimentation and observations shall be in the scope of the vendor.

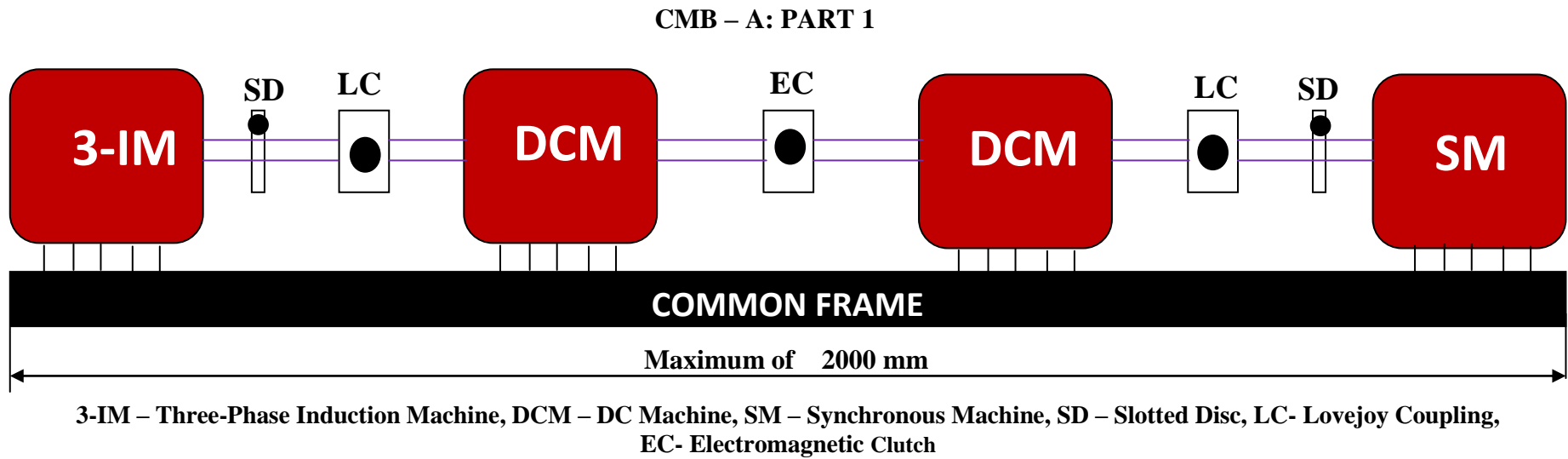
1. No-load, blocked-rotor and load tests on the induction machine.
2. DC motor speed-torque characteristics, DC generator characteristics, Hopkinson's test and Swinburne's test.
3. Synchronous machine OC/SC test, synchronization of the machine to ac grid by dark-lamp method, and determination of V-curves as generator and motor, determination of  $X_d$  and  $X_q$  of the machine.
4. Operation of the dc drive to demonstrate four quadrant operation, with speed control.
5. Operation of the ac drive to demonstrate speed control in all the modes with braking.
6. Operation of ac and dc drives in closed loop control with speed reference given as analog voltage.
7. Reports of all the above tests shall be submitted to NIT-Tiruchirappalli.

On successful completion of these tests, the prototype shall be type-approved.

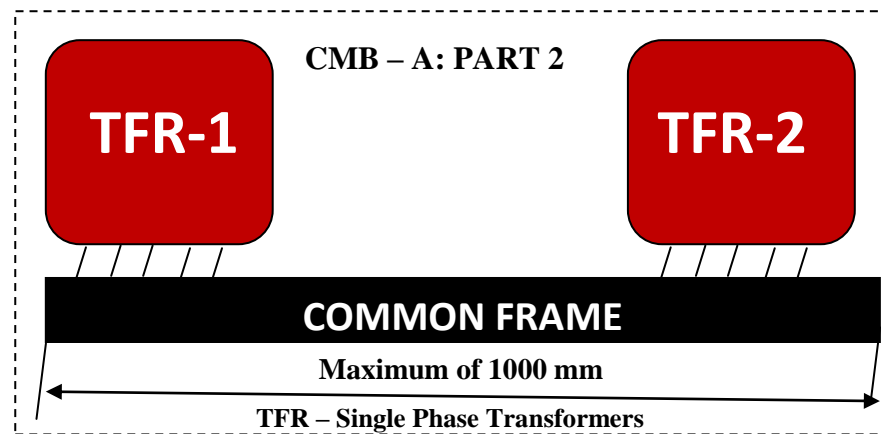
The vendor shall, for every setup, conduct tests to satisfy themselves of proper operation and certify the completion. Final acceptance of all units upon delivery and installation will be upon successful completion of all the above mentioned tests by NIT-T staff in the laboratory.



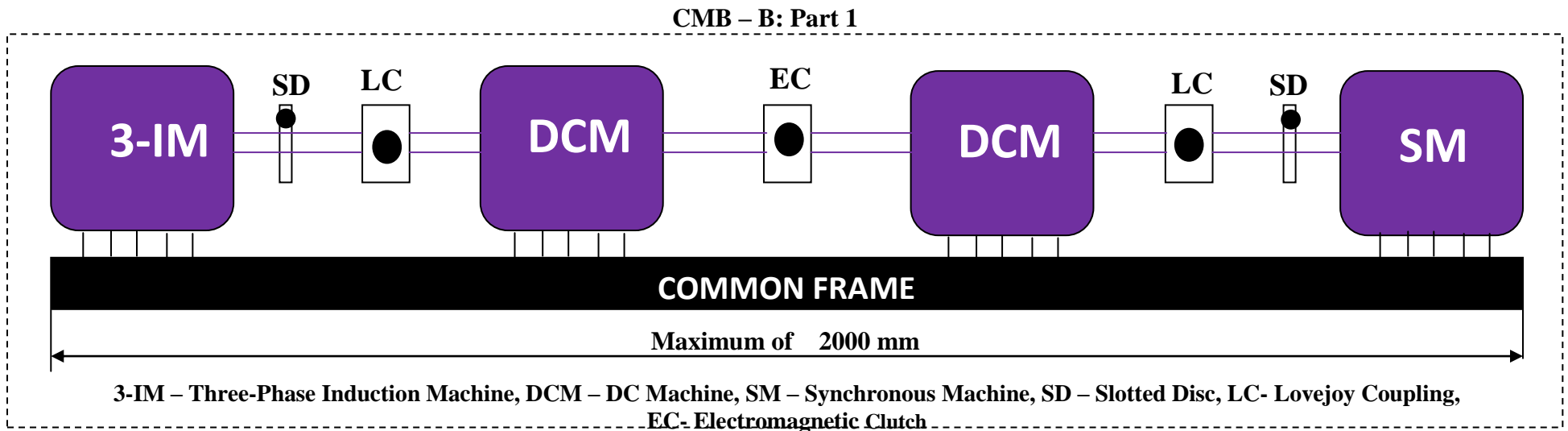
**Fig.1.** Lay-out for Single Work Station for Electrical Machines laboratory



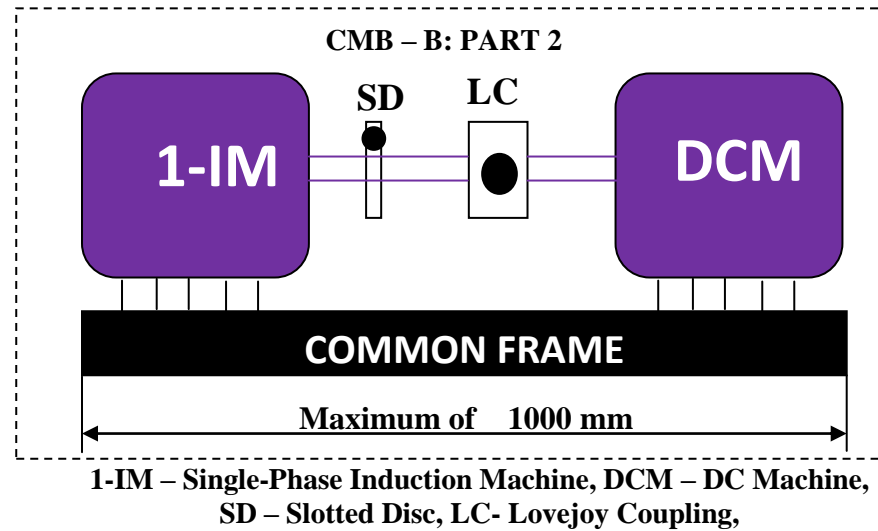
**Fig.2.** Lay-out for Composite machine Bench – A



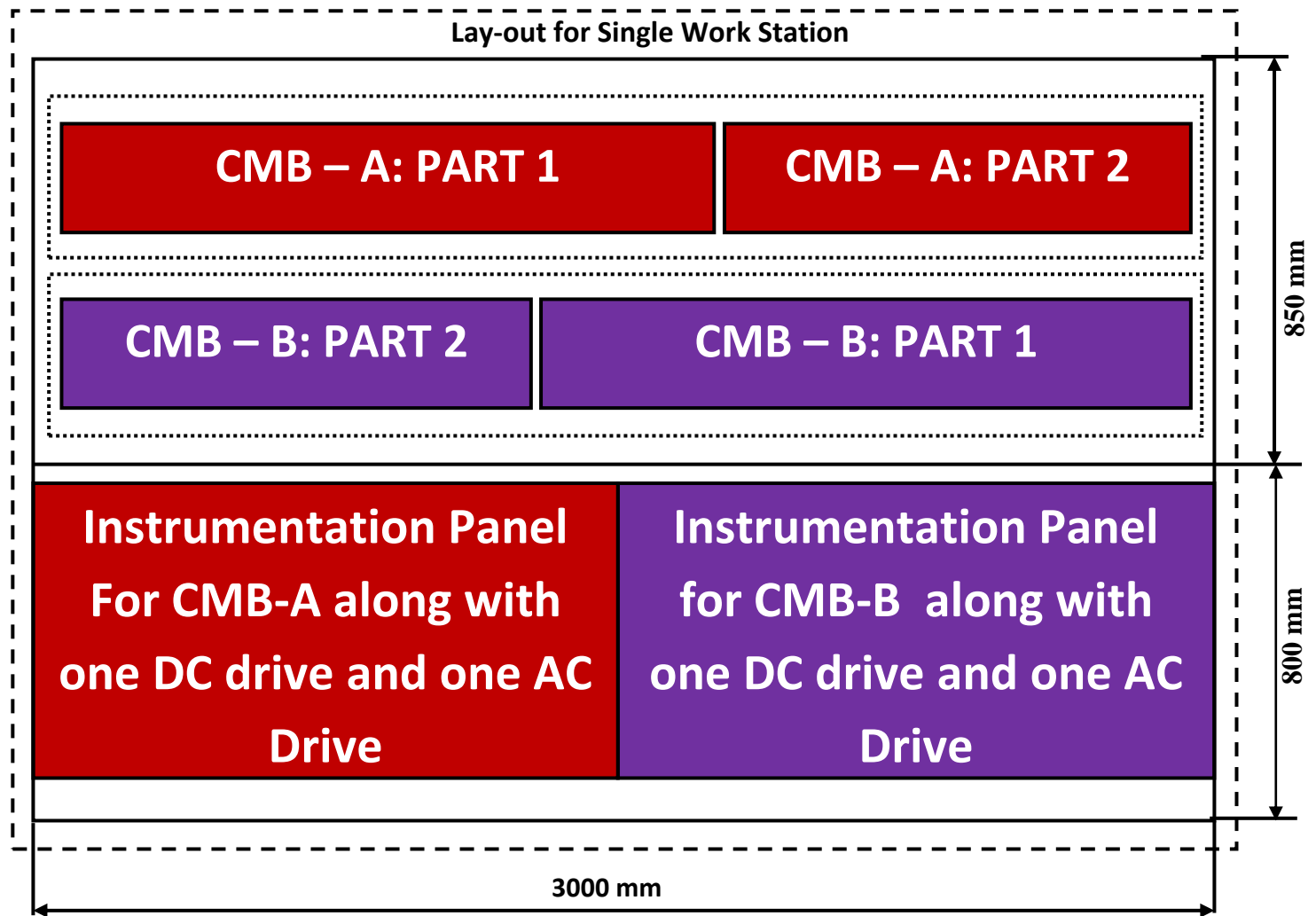
**Fig.3.** Lay-out for Composite machine Bench – A



**Fig.4.** Lay-out for Composite machine Bench – B



**Fig.5.** Lay-out for Composite machine Bench – B:



**Fig.6.** Lay-out for Single Work Station for Power Electronics Laboratory

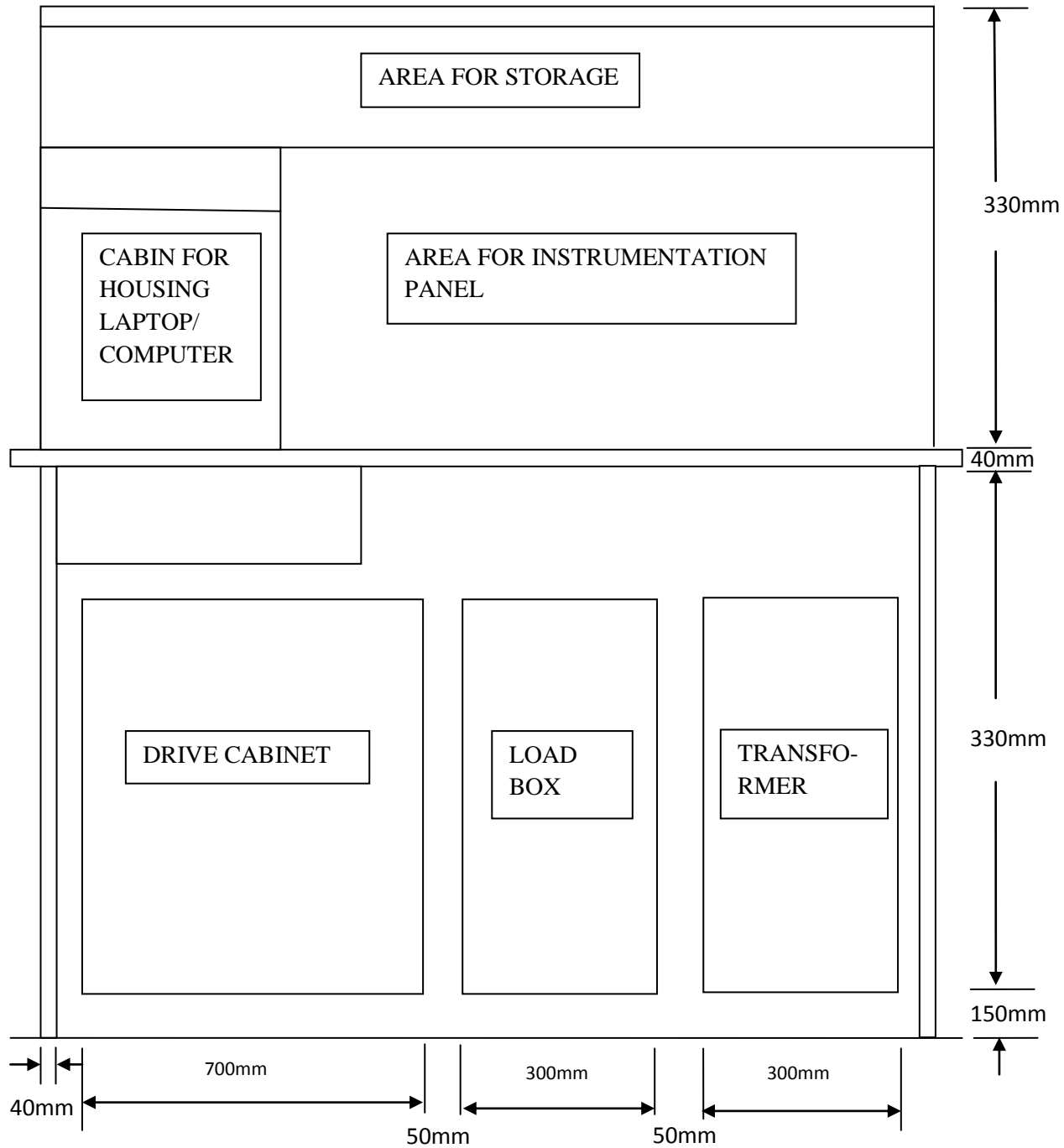


Fig.7 Layout of the wooden worktable-front view