IB 2022-12 – PROCUREMENT OF VARIOUS LABORATORY EQUIPMENT FOR THE COLLEGE OF ENGINEERING

SECTION VII- TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS

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Item	Specifications	Statement of Compliance
		[Bidders must state here either "Comply" or "Not Comply" against each of the individual parameters of each Specification stating the corresponding performance parameter of the equipment offered. Statements of "Comply" or "Not Comply" must be supported by evidence in a Bidders Bid and cross-referenced to that evidence. Evidence shall be in the form of manufacturer's un-amended sales literature, unconditional statements of specification and compliance issued by the manufacturer, samples, independent test data etc., as appropriate. A statement that is not supported by evidence or is subsequently found to be contradicted by the evidence presented will render the Bid under evaluation liable for rejection. A statement either in the Bidder's statement of compliance or the supporting evidence that is found to be false either during Bid evaluation, post-qualification or the execution of the Contract may be regarded as fraudulent and render the Bidder or supplier liable for prosecution subject to the applicable laws and issuances.]
1	**1- unit Engine Dynamometer with complete accessories** **Engine Test Set:** Instrumentation Dimensions: (fully assembled with fuel tank): Width 1400 mm x depth 300 mm x height 820 mm Dynamometer: Hydraulic variable fill Maximum absorption: 7.5 kW @ 7000 rev.min–1 Typical engine range: 3 to 4 kW, 3000 rev.min–1, 150 to 250 cc Speed measurement: Proximity pick up and digital display Torque measurement: Strain gauged load cell and digital display Air consumption measurement: Air-box and orifice plate, pressure transducer and digital display Ambient air temperature and barometric pressure measurement: Thermocouple, pressure transducer and digital display Exhaust temperature measurement: Engine thermocouple and digital display Fuel consumption: Precision volumetric fuel gauges **Modified 4 stroke petrol engine (electric start)** investigations into the performance and characteristics of a four-stroke petrol engine, including: • Torque, speed and power relationship • Brake mean effective pressure • Engine performance curves • Air and fuel consumption • Volumetric and thermal efficiencies *When used with engine cycle analyzer:*	

	• Plotting p-q and p-V diagrams • Engine cycle analysis • Indicated mean effective pressure • Indicated power • Comparison of brake and indicated mean effective pressures • Mechanical efficiency of the engine Engine capacity: 208 cc N e t P o w e r : 4.5 kW at 3600 rev.min–1 N e t T o r q u e : 12.5 Nm at 2800 rev.min–1 Speed: Governed to approximately 3600 rev.min–1 Cooling: Air cooled **Modified 4 Stroke Diesel Engine (electric start)** Learning outcome: • Torque, speed and power relationship • Brake mean effective pressure • Engine performance curves • Air and fuel consumption • Volumetric and thermal efficiencies • Willans line When use with engine cycle analyzer: • Plotting p-q and p-V diagrams • Engine cycle analysis • Indicated mean effective pressure • Indicated power • Comparison of brake and indicated mean effective pressures • Mechanical efficiency of the engine Engine Capacity: 232 cc Power and Torque: 3.1 kW at 3450 RPM Torque 10 Nm at 1700 RPM Speed: Governed to 3200 to 3400 RPM Cooling: Air cooled **Automatic Volumetric Fuel Gauge with Digital Read out** • Accurately and automatically calculates fuel consumption • Directly displays fuel consumption on digital read-out • Can cycle continuously or run once only • Self-sealing couplings enable quick and efficient connection and disconnection of fuel lines with minimum loss or spillage of fuel The Automatic Volumetric Fuel Gauge consists of a: • precision fuel gauge with sensors; • digital read-out (display) unit which shows fuel consumption and allows data to be transferred to a PC via the data acquisition system. The gauge mounts on the instrumentation frame of the test set and connects between the fuel tank and the engine under test. Fuel enters the fuel gauge from the fuel tank. A solenoid valve automatically shuts off the fuel supply from the tank so that the engine draws the fuel from the fuel gauge. Sensors on the fuel gauge record the time taken to consume a set volume of fuel, and the display unit automatically calculates the fuel consumption. The solenoid valve then opens and the fuel gauge refills. The unit can be set to continuously cycle in this manner or cycle once only **Versatile Data Acquisition** Software features include: • Recording data manually or automatically • Data capture set by time or intervals • Display of real-time data, in digital form or as an analogue meter	

	• Real-time traces of analogue signals • Logging data for printing and later analysis • Exporting data for use by other software • Performing real-time calculations to generate user defined data • Creating and printing charts and data tables • Customizable layouts Computer connection: • USB (lead included) Accessories (supplied): • All mains connectors and cables • STP (shielded twisted pair) cables for equipment connection Digital Inputs: • 6 off RJ45 connection • 4 off SPC (DTI) inputs Analogue Inputs: • 1 DIN type socket for dual trigger input • 2 DIN type sockets for signal inputs of 0 to 10 V or 4 to 20 mA • Sample rate up to 25 kHz with 12 bit resolution • Bandwidth/Filter cut-off 3 kHz (nominal) Data Export: • XLSX fi le (default) • HTML fi le (optional) **Engine Cycle analyzer** • Significantly enhances practical investigations, demonstrations and studies of internal combustion engines • Can also be used with other engines fitted with suitable cylinder head transducers and crank angle encoders • Includes powerful -based software specially designed for educational use • Automatic calculation and real-time display of p-q plots and p-V plots and other important parameters • Useful snap-shot, replay and animation functions • Accurate, clear animations of crank, piston, inlet and exhaust valve positions help students visualize the engine cycle • Students can export data for further analysis Learning Outcomes When used with suitable test engines, the analyser allows investigations into a variety of internal combustion engine characteristics, including: • The thermodynamic cycle of an internal combustion engine • Calculation of indicated mean effective pressure and indicated power • Comparison of indicated mean effective pressure and brake mean effective pressure • Mechanical efficiency of the test engine • Further work using exported data such as combustion analysis Crank angle input: Shaft encoder with 360 pulses per revolution Resolution: 1 degree Pressure Signal Conditioning: Precision charge amplifier with digital thumb-wheel calibration Maximum engine speed: 7000 rev.min–1	

2	**1-unit Universal Testing Machine** Max. Load 1000KN Load Accuracy ≤ ±1% ; Load Range 2%-100%F.S. ; Load Resolution 1/300000 Deformation measurement range 2%-100%F.S. Deformation accuracy ≤ ±1% Displacement resolution 0.01mm ; Displacement error ≤ ±0.5 Max. Piston Stroke 200mm Max.Piston Moving Speed 0-50mm/min Manual adjustment Max.Tension Test Space approx. 650mm Max. Compression Test Space approx. 550mm Round Specimen Clamping Range Φ14-60mm Power supply: 3 phase / 220V / 60Hz	
3	**1-unit Oven** Digital Display Constant Temperature Convection Oven Specifications: 1. Temperature range: 50-300°C 2. Accuracy: ±1°C 3. Heater: 2 groups 4. Perspective window to look inside 5. Working voltage: AC220V 6. Capacity approx.: 225L	
4	**1-unit Coring Drilling Machine** Technical Specifications: 1.Max. diameter of core: Ø200mm; 2.Max. drilling depth: 400mm 3. Max. drilling depth of core sample: 150mm 4.Rotating speed of main axis: 800-1200rpm 5. Direction of cutting (grinding): lateral 6. Way of enter: Manual 7. Motor's power: 5.5KW (4.42hp) 8. Motor voltage: AC220V	
5	**1-lot Electrical Engineering Laboratory Equipment** Interface: Equipment: • 32-bit processor with storage memory for measurements • USB interfaces, transfer rate 12 Mbits/s • WLAN/WiFi interface, 2.4 GHz, IEEE 802.11 b/g/n • Simultaneous connection of any number of Experimenters via serial bus system • High-quality designer casing with aluminium feet and surface-hardened Plexiglas front panel • Suitable for accommodating in training panel frames for DIN A4 training panels • Designed for connection of 2-mm safety measuring leads • Multi-coloured LEDs for displaying status • Adjustable analog output, +/-10 V, 0.2 A, DC – 5 MHz, via BNC and 2-mm sockets	

	• 4 Analog differential amplifier inputs with 10 MHz band width, safe for voltages up to 100 V, sampling rate 100 mega samples, 9 measuring ranges, memory depth 4 x 8 k x 10 bits, inputs via BNC (2 inputs) or 2-mm sockets (4 inputs) • 2 Analog inputs for current measurement, overcurrent-protected up to 5 A, sampling rate 250 kilo samples, 2 measuring ranges, resolution 12 bits, connection via 2-mm sockets • 3 variable analog outputs +/- 20V, 1 A, DC-150 Hz • 16-bit digital signal output, of which 8 bits are accessed via 2-mm sockets, TTL/CMOS, clock frequency 0 – 100 kHz, electric strength +/- 15 V • 16-bit digital signal input, of which 8 bits are accessed via 2-mm sockets, memory depth 16 bit x 2 k, TTL/CMOS, sampling rate 0 – 100 kHz, electric strength +/- 15 V, • 8 Relays, 24 V DC/1 A, of which 4 are accessed via 2-mm sockets • External power supply with wide range input 100-264 V, 47-63 Hz, output 24 V / 5 A <u>Virtual instruments (meters and sources):</u> • 2 x Voltmeter VIs, 2 x Ammeter VIs: AC, DC, 9 ranges, 100 mV to 50 V, true RMS, AV • 1 x Power meter, 9 ranges, 100 mV to 50 V • 1 x VI with 8 relays, 1 x Multimeter VI: multimeter display software • 1 x 2-channel ammeter VI: AC, DC, 2 ranges, 300 mA and 3 A, TrueRMS, AV • 1 x 2-channel voltmeter VI: AC, DC, 9 ranges, 100 mV to 50 V, TrueRMS, AV • 1 2-/4-channel oscilloscope: band width 10 MHz, 25 time ranges, 100 ns/div to 10 s/div, 9 ranges 20 mV/div to 10 V/div, trigger and pre-trigger, XY and XT modes, cursor function, addition and multiplication function for 2 channels • 1 x VI Spectrum Analyzer: 9 voltage ranges 100 mV to 50 V, input frequency range 3 Hz to 1 MHz, time domain display • 1 X VI Bode-Plotter: 9 voltage ranges 100 mV to 50 V, frequency range 1 Hz - 5MHz, time domain display and locus diagram • 1 x Adjustable DC voltage VI 0 - 10 V • 1 x Function generator VI: 0.5 Hz - 5 MHz, 0 - 10 V, sine, square, triangular, • 1 x Arbitrary generator VI, 1 x Pulse generator VI • 1 x VI with 16 digital outputs, 1 x VI with 16 x digital inputs, 1 x VI with 16 digital input/outputs. Display modes: binary, hex, decimal and octal numerals • 1 x Three-phase power supply VI, 0 - 150 Hz, 0 - 14 Vrms, 2 A • 1 x Adjustable DC power supply VI, 3 x (-20 V - +20 V), 2 A • 1 x Three-phase power supply VI with additional phase-shift and clock rate adjustment <u>Includes:</u> • Interface • Power supply	

	• Power lead • USB cable • with basic software • Operating manual Experimenter Equipment: • Connects to the Unit Interface and additional Experimenters via Unit bus • Unit bus connection for experiment cards • High-quality designer casing with aluminium feet and surface-hardened Plexiglas front window • Suitable for accommodating training panel frames for DIN A4 training panels • Fixed and variable voltages available via 8 2-mm sockets • Designed for connection of 2-mm safety measuring leads • Accommodates Unit experiment cards • Eject mechanism for Unit experiment cards with return spring • Accommodates a breadboard for experimenting with discrete components and integrated circuits • Accommodates a multi meter using IrDa interface Shunt resistors on a PCB, for current measurement using the analog inputs of the Unit system. • 6 Shunt resistors: 2 x 1 ohm, 2 x 10 ohm, 2 x 100 ohm • Screen print of symbols for identifying resistors, the voltage taps and current inputs • 24 x 2-mm sockets • Dimensions: 100 x 40 mm Set of connection cables 2 mm (28 pcs) for Unit consisting of: • 8 x connection leads 2 mm, 15 cm, blue • 4 x connection leads 2 mm, 15 cm, yellow • 5 x connection leads 2 mm, 45 cm, black • 2 x connection leads 2 mm, 45 cm, yellow • 5 x connection leads 2 mm, 45 cm, red • 2 x connection leads 2 mm, 45 cm, blue • 1 x safety adapter lead 4 mm to 2mm, 50 cm, black • 1 x safety adapter lead 4 mm to 2mm, 50 cm, red m connector plugs / Plug spacing 5 mm, white Universal precision lab multimeter and temperature meter with IR interface for high-quality • 3¾-digit multimeter; resolution: ±3,100 digits • Measurement classification CATII-1000 V • Can be connected to Unit system via IR interface • Voltage and current measuring ranges: 30 mV-1000 V DC, 3 V-1000 V AC; 3 mA-16 A DC; 30 mA-10 A AC • Resistance ranges: 30 ohm-30 Mohm • Continuity and diode testing • Automatic range selection and battery shut-off, min./max. and data hold function	

	• Safety fuse for current measurement range up to 300 mA • Protection against high currents in the mA range for nominal voltage of 1000 V • Display with bar chart and backlighting • Includes protective sleeve, measuring leads, 1 x spare fuse, 9V battery, test certificate according to DIN 43751 Sturdy aluminium case with moulded foam block to accommodate a complete Unit system (without equipment) • Capable of accommodating 1 Interface, 2 xperimenters, 1 power supply as well as cables and maller accessories • Lockable padlock; stable padlock hinge • Colours: aluminium, black, chrome • Dimensions: 610 x 480 x 100 mm **Course - Electric Machines 1: DC machines** <u>Includes:</u> • 1 Experiment card with open, 2-pole stator and 2 exciter windings, temperature sensor with voltage source, starting and load resistors • Rotor with adjustable brushes • Stroboscope with extra-bright LED • Software browser and course software <u>Course contents:</u> • Identifying the most common applications for DC machines • Explanation of electromagnetic induction and the Lorentz force • Explanation of design and function of commutated machines (DC machines) • Introduction to the key components of commutated machines, stator, commutator and carbon brushes • Measurement of current and voltage in armature and exciter and determining the armature and exciter impedances • Interpreting a rating plate • Introduction to circuit diagrams and characteristics for various types of connection: series, shunt and compound windings • Connection and operation of DC machines in various operating modes • Speed measurement using a stroboscope • Introduction to various types of speed regulation and reversal: field weakening, modification by means of armature and field resistors • Experimental investigation of various methods for controlling speed and direction of rotation • Connection and operation of commutated machines with AC voltages: universal motors • Introduction to methods of braking DC machines • Measurement of current and voltage when braking DC machines • Explain the importance of temperature monitoring for electrical machines	

	Temperature measurement in the exciter winding when a machine is running using a semiconductor sensor **Course - Electric Machines 2: Asynchronous machines** Includes: • 1 Experiment card with stator and three-phase winding,run-up and operating capacitor and temperature sensor with constant current source • 3 Rotors: squirrel-cage, permanent-magnet, rotor with open winding • Stroboscope with extra-bright LED • Software browser and course software • Storage case Course contents: • Identifying the most common applications of rotating field machines • Explanation of the principles of electromagnetic induction • Explanation of the design and function of rotating field machines • Explanation of the differences between motor and generator operation • Introduction to the key components of a rotating field machine, the rotor and stator • Experimental demonstration of how torque arises and of the generator principle • Creation of a rotating magnetic field by rotating field machines: experimental demonstration of a rotating magnetic field in the stator • Introduction to the principle of a 3-phase transformer • Investigation by measurement of three-phase machines in star and delta configurations. • Measurement of phase-to-phase and line-to-line voltage and current • Measurement of rotor voltage and current • Interpreting a rating plate • Nominal data and characteristic parameters, power factor, pole-pairs, torque, speed and slip • Design and function of asynchronous machines • Investigation of a squirrel-cage rotor, frequency response characteristics, reversal of rotation • Investigation by measurement of the operating response of a synchronous machine with a permanent magnet rotor • Introduction to the principle of a capacitor motor (Steinmetz circuit) • Investigation by measurement of the operating response of a capacitor motor • Explanation of the importance of temperature monitoring in electrical machines • Measurement of winding temperature in running machines • Fault simulation (4 simulated faults activated by relay)	
6	**1-lot Engineering Science Set** (Experiment Kits such as: Forces Kit, Moments Kit, Deflection of Beams and Cantilevers Kit, Torsion of Circular Sections Kit, Tensile Tester Kit, Simple Harmonic Motion Kit, Friction and Inclined Plane Kit, Potential and Kinetic Energy Kit, Pulley Kit, Drive	

	Systems Kit, Cam Crank and Toggle Kit, Gear Trains Kit, Simple Mechanisms Kit, Bar Linkages Kit, Centrifugal Force Kit, Rotational Friction Kit, Additional Mechanisms Kit, Spring Tester Kit) **Detailed Specifications and Requirements:** Main parts: • **Mobile trolley** x 1 • Work Panels x 3 • All 18 Science experiment kits • Spares Kit x 1 • Empty trays x 5 • **Forces Kit** Learning outcomes • Centres of gravity • Force triangles • Force polygons and Bow's notation • Linked polygons (non-concurrent forces) • **Moments Kit** Learning outcomes • Principle of moments • Beam balances • 1st, 2nd and 3rd order levers • Bell crank lever • Beam reactions Main parts: • Rigid beam with hook points • Bell crank lever with hook points • Spring balances • Pulley • Weight hangers and weights • Cord and hooks • **Deflection of Beams and Cantilevers Kit** Learning outcomes • Beam length and deflection • Beam material and deflection (Young's modulus) • Beam 'I' value and deflection • Beam supports (cantilever, propped cantilever, fixed beam and simply supported) and deflection Main parts: • Choice of beams • Dial indicator • Dial caliper • Fixing blocks • Rule • Weight hangers and weights • Hexagon tool • **Torsion of Circular Sections Kit** Learning outcomes • Specimen length and angle of twist • Specimen material and angle of twist (modulus of rigidity) • Specimen 'J' value and angle of twist Main parts: • Choice of specimens • Rotating and fixed chucks • Dial caliper • Rule • Weight hangers and weights • Hexagon tool • **Tensile Tester Kit** Learning outcomes • Tensile tests (to destruction) of different materials • Finding the tensile strength of a material • Material behaviour in the elastic and plastic region • Creating a force and extension chart Main parts: • Tensile tester • Dial caliper • Set of specimens – 10 x steel, 10 x aluminium, 10 x aluminium HE30 and 10 x PVC • Hexagon tool • **Simple Harmonic Motion Kit** Learning outcomes • Simple harmonic motion of simple, bifilar and trifilar pendulums of different length and mass • Simple harmonic motion of a spring with different masses, and a simple spring rate test • Simple harmonic motion of a compound pendulum • Simple harmonic motion and gravity using a Kater's pendulum Main parts: • Top plate (supports the pendulums) • Kater/compound pendulum • 2 x simple pendulums (aluminium and brass) • Bifilar suspension bar • Trifilar plate • Spring • Weight hanger and weights • Stopwatch	

	• **Friction and Inclined Plane Kit** Learning outcomes • Forces on an inclined plane • Rolling and sliding friction on different surfaces • Kinetic and static sliding friction between different surfaces • Surface angle and friction between different surfaces Main parts: • Inclinable plane • Car or sled • Different surfaces • Weight hangers and weights • Roller Set • **Potential and Kinetic Energy Kit** Learning outcomes • Kinetic and potential energy in a pendulum • Elastic potential energy in a spring • Kinetic energy in a flywheel Main parts: • Pendulum • Flywheel • Spring • Weight hangers and weights • **Pulley Kit** Learning outcomes • Simple pulleys - fixed, movable and compound • The wheel and axle • The Weston differential pulley Main parts: • Single, double and triple wheel (sheave) pulleys • Weston differential pulley • Wheel and axle • Weight hangers and weights • **Drive Systems Kit** LEARNING OUTCOMES • Power transfer, efficiency and direction in a belt drive • Power transfer and efficiency in a chain drive • Input and output relationships of a universal coupling • Friction and angle of lap on a pulley Main parts: • Chain drive • Belt drive • Universal coupling • Weight hangers and weights • **Cam, Crank and Toggle Kit** Learning outcomes • Displacement and angle characteristics of pear, heart, round and spiral cams • Characteristics of a mechanical toggle • Turning moments and forces during crank motion Main parts: • Pear, round, heart and spiral cams • Set of followers • Toggle linkage • Crank and slider • Masses • **Gear Trains Kit** Learning outcomes • Characteristics of spur gears, including single and compound gear trains and the 'idler' gear • Characteristics of a bevel gear • Characteristics of a worm drive Main parts: • Four spur gears of different teeth ratio • Worm drive set • Bevel gear set • Weight hangers and weights • **Simple Mechanisms Kit** LEARNING OUTCOMES • Conversion of motion using the 'Scotch yoke' (or 'slotted link') • Conversion of motion using the quick return mechanism • Conversion of motion using the crank and slider Main parts: • Scotch yoke • Crank and slider • Quick return mechanism • **Bar Linkages Kit** Learning Outcomes • Four-bar linkages – crank rocker, double rocker, drag link and parallelogram • Straight line linkages – Watt's straight line, Chebyshev,	

	Peaucellier-Lipkin, Hart's inversor, Robert's and Hoeken's • Pantograph • Ackermann steering Main parts: • 4 bars with 17 holes • 6 bars with 13 holes • 6 bars with 9 holes • 6 bars with 5 holes • Joints and pen holders • Magnetic wipeable sheets • Non-permanent markers • Screwdriver and spanner **• Centrifugal Force Kit** Learning Outcomes • Relationship between centrifugal force, radius and velocity of different rotating masses Main parts: • Rotating frame • Weight hanger and masses • Stopwatch **• Rotational Friction Kit** Learning outcomes • Efficiency of a screw jack • Efficiency of a wedge • Efficiency of different bearings Main parts: • A screw jack • Four different bearings • Two wedges of different angle • Weight hanger and masses **• Additional Mechanisms Kit** Learning outcomes • Conversion of motion using the Geneva mechanism • Conversion of motion using a ratchet Main parts: • Geneva mechanism • Ratchet mechanism **• Spring Tester Kit** Learning Outcomes • Hooke's law and compression spring tests • Hooke's law and extension spring tests • Parallel and series spring tests Main parts: • Compression spring tester • Dial caliper • Assorted coiled springs • Rule • Masses	
7	**1-unit Mig Welding Machine** ● Input 220VAC, three (3) phase ● Amperage range: 50-280 Amps ● 50% duty cycle at maximum amperage	
	***** Bidder should provide training on the use of equipment to at least 8 personnel and free re-training during warranty period** ******Warranty on parts and labor is at least 1 year**	
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Name of Bidder over Printed Name

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Date