Technical specifications for 200 kV Transmission Electron Microscope with accessories:

Quantity: 1 if not mentioned

NOTE: The specifications are divided into two sections, A and B. Quotations are invited either for all or only one section.

Sl. No.	Features	Required specifications
A	**Instrument**	
1.	Power requirement	Single Phase, 220/240V, 50 Hz.
2.	Accelerating voltage	200 kV FEG HRTEM with alignments at-least at 80,120,160,200 kV for TEM-STEM and EELS (variable either in steps or continuous)
3.	Electron source	Filament Type: Schottky Field Emission Gun with energy resolution ≤0.8 eV. Electron gun lens may be electrostatic in nature.
4.	Possible types of operating modes	(a) TEM and HRTEM (Bright field and dark field) (b) STEM mode (c) Nano –Probe (d) Annular Bright field Imaging (e) Annular and High Angle Annular Dark Field Imaging (f) Selected Area Diffraction including Nano diffraction (g) Convergent Beam Electron Diffraction (using TEM/STEM modes) (h) EDS using TEM/STEM modes. (i) CRYO – TEM with using Cryo holder and accessories. (j) In-situ, double-tilt, heating holder (≥800 oC) (System should have capability of simultaneous analysis modes such as: STEM + EDS/EELS, STEM + Image recording, Cryo + EDS/EELS, Heating + EDS/EELS, EDS+EELS, wherever possible. Changes between various operating modes should be computer controlled and motorized. A model with complete remote operation mode and complete compliance with the specifications in Section A may be optionally quoted.

5.	Resolution	TEM/HRTEM: Point-to-point resolution ≤0.24 (or better) nm and lattice resolution ≤0.14 nm (or better) with a high resolution pole piece compatible with EDS, Cryo-system and tomography. STEM resolution: 0.17 nm or better Information Limit 0.12 nm of better STEM HAADF resolution: 0.19 nm or better
6.	Magnification for imaging	50X to 1.2M or higher range of magnification for TEM. 150X to 200MX or higher for STEM.
7	Camera Length for Diffraction	100 mm to 1200 mm or larger range
8	Imaging	Low/minimum dose mode should be included for beam sensitive samples
	Permissible Drifts and Aberrations	i. Specimen drift ≤1 nm/h ii. Spherical aberration ≤1 mm and Chromatic aberration ≤1.2 mm
9.	Vacuum System	Oil free Ion Getter Pumps/Sputter Ion Pumps for Column, Gun and Specimen chamber. Fully automatic sequential control for operation of vacuum pumps. Built-in automatic control of bake-out system. FEG gun area vacuum should have pressure ≤$1X10^{-7}$ Pa and TEM column area vacuum should be better than 10^{-5} Pa.
10.	Lens System	Condenser apertures: Computerized motor-driven automated mode for aperture change operation is preferred. Objective lens with upper and lower pole pieces (double objective lens with objective lens and objective mini-lens may be quoted as option). The one closer to the sample should have option to switch off in case of magnetic samples (any calibration requiring this operation should be included) Selected area/field limiting aperture: motor driven mode of operation is preferred with ≥3 diameters should be made available. Spherical Aberration of objective lens ≤ 1.2 mm Chromatic Aberration of objective lens ≤ 1.4 mm
11.	STEM	Scanning transmission electron microscope with HAADF detector: On-axis retractable STEM bright field, annular bright-field and dark field, as well as high angle annular dark field (HAADF) detectors supplied with software for data acquisition and analysis. Imaging in Z (atomic number) contrast mode should be possible. STEM bright field image resolution: ≤ 0.17 nm or better STEM HAADF resolution: ≤ 0.2 nm or better STEM image magnification ≥2,000,000 times or higher. 4 parallel imaging channels should be available to acquire 4 or more images at the same time from different STEM detectors. Piezo-controlled Drift correction facility should be provided for

		STEM to facilitate long duration acquisition of characteristic X-rays from a given area of a sample for the purpose of elemental mapping.
12.	Specimen Holders	Low background double tilt holder: 1 No. Regular double tilt holder: 1 No. Double-Tilt heating holder up to 800 ^{0}C:1 No. Single-tilt holder: 1 No. Single tilt Cryo-Holder (temperature down to -170^{o}C): 1 No. with necessary liquid nitrogen pumping station and related essential accessories. Single-tilt multi-specimen holder (for grid size 3 mm). Tomography holder
13.	Facilities for Cryo-TEM	Cryo-transfer station with necessary accessories Anti-contamination device (ACD) or equivalent facility Cryo-plunger Temperature controller Dry pumping facility (for 3 holders) Tilt range ± 70^{o} or better. Minimum /Low Dose imaging and system control software.
14.	Specimen Chamber	Goniometer should be motor-driven, eucentric, side entry type with Z-movement being fine-controlled. Piezo stage should be included for drift reduction and control, minimum stage should be 0.04 nm or less. A piezoelectric drive system for shifting of field view at high-resolution magnification with a drift-free/backlash-free control unit and a suitable drive-control power supply may be offered as optional feature Tilt angles should be ± 30^{o} or more with motorized specimen tilting about two perpendicular axes for crystallographic analysis. Maximum tilt for tomography application should be ± 70^{0} or more The permissible tilt may vary with type of holder used. X-Y movement: ≥ ±2 mm, motor driven (manual or computer controlled with specimen position recall facility) Z movement ≥ ±0.4 mm (or more), motor driven for specimen height adjustment.

		Image fine shift: Electromagnetic shift mechanism for X-Y translation. Facility for recording specific specimen translation position as reference point in the memory.
15.	Automation	It should be possible to align both electron gun and beam at selected acceleration voltages, save it in the computer, and recall that for automatic alignment while switching from one acceleration voltage to another. This should be possible for at least 80kV, 120 kV, and 200 kV operations. Changing between all different imaging and diffraction modes should be computer controlled and motor driven.
16.	Energy Dispersive Spectroscopy Facility	The EDS detector should be LN2 free using SDD crystal having a total area of atleast 100mm^2 for higher throughput at lower beam currents. The EDS detector resolution should be 127eV or better. The EDS detector should be without window (windowless configuration) The detection of elements should be Beryllium (Be) onwards. The detector should be protected by a pressure sensor to switch it into safe mode when loss of vacuum is detected. The EDS system software should allow elemental analysis and elemental mapping facility in TEM/STEM mode. Simultaneous acquiring of EDS and EELS spectra/mapping should be possible
17.	3D Tomography	Facility for 3D tomography in TEM/STEM/EFTEM mode should be quoted, using a single tilt specimen holder (rotation angle ± 70^o). Software supporting acquisition experiments using TEM, STEM or EFTEM modes should be supplied. Softwares (64 bit) for automatic acquisition and montage of images in TEM and STEM modes of operation, along with 3D reconstruction (GPU and non GPU version). It should also be applicable to EDS and EELS to obtain 3D distribution of elements. 3D visualization software should be included.
18.	Secondary/backscattered Electron Detector	Secondary electron detector and backscattered electron detector may be included for imaging various types of specimens as mentioned above at cryogenic, ambient, and high temperatures.
19.	Plasma cleaner	To effectively remove organic contamination from specimen and specimen holder, the system should have a low energy glow discharge ion source creating hydrogen and oxygen radicals. Should be compatible with both TEM and SEM samples. An additional mass-flow controllers (MFC) should support three independent process gases (Argon, Hydrogen, and Oxygen) for accurate gas control and long term plasma stability. Two ports should be

		available to accept all side entry TEM holders. Should be capable to clean holey carbon grids without damaging them. Data supporting this should be included along with the offer. It should useful to make carbon coated TEM grids hydrophilic. Standard recipes for SEM, TEM, STEM and carbon coated grids should be supplied along with equipment. Appropriate gas cylinders and regulators are to be provided. Adequate UPS for uninterrupted power supply for 1 h operation should be provided.
20.	Calibration standards	Standard samples to check system calibration i.e., magnification and camera length should be supplied along with the system, including TEM Standard Au/any other standard sample for TEM resolution, Standard sample for magnification calibration and orientation calibration, STEM Standard Si 110 dumbbells for STEM resolution, Mn standard for EDS energy resolution
21.	Output Recording System	Complementary metal-oxide semiconductor (CMOS): High resolution CMOS Camera of minimum 4K x 4K pixel. Should have CMOS sensor with built-in shutter. Sensor active area should be ≥3720 mm2, and pixel size ≈ 15 micrometers. Full sensor read out speed should be ≥25 fps. Fully EELS compatible & retractable. Recording modes should include both "image" and "video". Ability to view "live" video of in-situ TEM experiments at resolution of 4096 X 4096 pixels at 25 frames per second (fps) to 512 X 512 pixels at ≥300 fps, with usage of the In Situ upgrade option and with suitable high end server type PC configuration. It should be possible to do in-line data processing with real time drift correction at 25 fps. User-friendly software facility for astigmatism correction at high magnification for HRTEM imaging Output images should be compatible with other commercial image analysis software On–line annotation for scale bar, magnification and TEM condition should be available. On-image facility for linear measurement as diffraction measurements for ring and spot pattern The software should include online and offline data processing features like FFT and full support for real space (image mode) and reciprocal space (different mode) calibrations. A retractable CCD camera fitted to a 35 mm port may be included. Separate PC for this camera.
22.	Tool kit	Suitable and essential tool kit is to be supplied with the system for the required maintenance.
23.	Spares, consumables and	All essential spares should be included in the offer. The spares should include emitter (1 No.), two sets of all O-rings, one set of all kinds of valves, a set of screws used in different specimen holders,

	accessories	and all types of consumables. Any cylinders and regulators for gases (such as argon, N2) to be used with the instrument or accessories to be provided by the vendor. The supplier should guarantee that all spares should be available for 10 years from the date of installation.
24.	Other accessories and consumables	Vacuum Pick-up for TEM grids Acid resistant High precision tweezer (10 no. each of straight and bent type) High precision Titanium tweezers (10 no.) Anti-capillary tweezers (10 straight, 10 self-closing) TEM grids (should have one shiny and one matte finish side, all are between 100 to 200 mesh, whatever higher is available) (1) carbon coated holey grids (2000 no) (2) Tomography grids (500 no) (3) grids without C-coating (500 nos) (4) numbered grids (500 no), (5) Lacey carbon grids (1000 no), holey carbon coated Titanium grids (200 no), holey carbon coated Ni grids (500 no). holey carbon coated Gold grids (100 no). reference, locator, finder or index grids (200 no)
25.	Chiller and Compressor	Suitable compressor and chiller for the main equipment should be supplied along with the TEM system. Close circuit, automatic temperature and flow rate controlled chiller.
26.	Display and output	Two larger than 21″ high definition monitor(s) for HRTEM operation for split display of image recording/processing, and EDS analyses. One Color Laser Printer and one B/W laser printer (both with photocopy/scanning facility) should be provided.
27.	CPU and software	Latest compatible branded high speed computer (i5 or higher) with pre-loaded licensed software for all operating parameters. Specify computer speed, processor, RAM and graphics card. All the computers for HRTEM must be imported /factory fitted and tested with pre-loaded softwares for operating these systems. All softwares used to operate the instrument, acquire and process the data should be licensed and should be factory preloaded. Include an in-situ video software that synchronizes images with data from in-situ devices. Include software that automates adjustment of focus, astigmatism, and misalignment. Include a software for stage and optics control so that one can seamlessly stitch images together. Include a software that facilitate acquiring HREM assays by automatically adjusting the critical imaging parameters of a TEM microscope focus, stigmation and beam tilt. Include a diffraction analysis software package to automate the selection area of electron diffraction (SAED) patterns and high resolution lattice images of crystalline samples. All software should preferably be from a single

		supplier for seamless performance. Software for stimulation and magnetic property studies Three no. of offline versions of all softwares should be included. A separate PC (with HD monitor) and a laptop with touch screen having all loaded software should be provided.
28.	Safety Devices	The TEM should be equipped with self-diagnostic functions to detect problems like pneumatic pressure abnormality, cooling water temperature abnormality, reservoir tank pressure abnormality, etc.
29.	Uninterrupted Power Supply (UPS):	On-line uninterrupted Power Supply (UPS) system should be supplied for HRTEM and Chiller. The UPS should be able to keep the TEM operational in case of sudden power cut or spike and support the complete TEM system with all accessories with full load for duration of 1.5 hour. There should be 5 years on-site comprehensive warranty for UPS, including onsite replacement warranty for batteries from the date of installation. A suitable generator should be supplied for prolonged power interruption.
30.	Pre-installation requirements	Pre-installation requirements such as room size, tolerable limits of electromagnetic field and vibration (mechanical), required power rating, utility requirements are to be stated clearly, and to be verified/surveyed by the supplier at the installation site. It is the supplier's responsibility to develop the site (after due discussion with the indenter) and make it ready before 60 days of delivery of the equipment.
31.	Environmental requirements	Necessary environmental requirements, i.e., temperature, humidity, air-conditioning, vibration isolation, stray magnetic field, electrical connections/earthing requirement, etc during the operation of HRTEM should be taken care of by the supplier.
32.	Installation and commissioning	The manufacturer should undertake to install and commission the equipment and all attachments accessories and also demonstrate the performance guaranteed as per specifications at site.
33.	Required Documents along with technical specifications	The supplier must provide a comprehensive list of users of HRTEM (Schottky Field Emission type) in India. They should also submit the name(s) of the service engineer(s) employed by them who is/are competent to service the equipment along with their locations in India.

34.	Man power	A person trained on the same instrument is to be appointed for proper operation and functioning of the instrument from the date of installation for next five years. A separate quote for the salary of this person for five years is to be provided. Payment for manpower shall be made on half yearly basis separately against satisfactory performance. The operator will work as an employee of the vendor and institute shall have no responsibility for his/her service liabilities.
35.	Electron Energy Loss Spectroscopy Facility with Energy Filtering	Energy resolution for zero loss peak should be 0.1 eV FWHM in the best TEM operating conditions. Maximum distortion = 0.75 % Chromatic dist =0.2 % per 50 eV Elemental mapping in STEM mode should be possible with spectral acquisition rate of at least 1000 /s. Should have fast camera modes Should have electrostatic Shutter (1µs). Should have advanced bright field and dark field STEM detectors Aperture size (mm): 2.5,5 and 9 Software packages for entire range of operations and applications including EDS/EELS combined mapping, fast spectral acquisition, EELS mapping and EELS tomography, qualitative and quantitative analysis, extended range acquisition, simultaneous multi-element mapping and enable simultaneous acquisition of two spectra with different energy offsets and exposures, simulation tool for compositional mapping, spectrum imaging etc. STEM Diffraction imaging module, Advanced AutoFilter suite, GIF Tridiem® 863 upgrade to Gatan Microscopy Suite 2 package should be included
36.	Other accessories	Vacuum Oven and accessories, Homogenizer, ball mill powder crasher, High Vacuum Carbon Coater (which can also coat metals or metal/carbon simultaneously) and its accessories, spin coater, Stereo microscope, Ln2 storage (50 L) and carrying facility (8-10 L).
37.	Compliance Statement	The supplier must submit a table indicating the compliance of the features of the model of the equipment being quoted with those given in the indent. Features not matching – must be clearly indicated. Additional features and features in the quoted equipment which are better than those in the indent – may be clearly explained. The supplier must submit technical brochures and proper application notes adequately explaining and confirming the availability of the features in the model of the equipment being quoted.

B	**Sample preparation facilities**	
38.	Ion beam milling	Preferable specifications: With two independently adjustable ion guns (100 eV to 5 kV or better) with variable milling angle ($+10^{o}$ to -10^{o}), with current range variable from 0 to 80 micro Amps or better, with stereomicroscope, with cold stage milling capability (dewar capacity for 5 h or better should be supplied), with oil free vacuum system, complete with standard accessories and spares. The current should be

		measurable for each gun independently and measured at the gun. Ion gun should produce narrow ion beam width at the sample (full width at half maximum of the beam diameter shall be around 600-800 um for standard guns at 5 kV with ion current density of ~10mA/cm-2). The current should be measurable for each gun independently and measured at the gun. The specimen holder should be able to hold 3 mm diameter TEM specimens. The Specimen stage should have provision for the rotation of the specimens during milling. Rotational speed shall be continuously variable from 0 – 5 rpm or better. Cold stage should offered as standard as per the following specifications: Dewar and conductor rod should share the main vacuum system, min 6 hour Dewar capacity. Electronic temperature regulation: range (-180ºC to + 100ºC or better). In-situ viewing should be possible any time without shutting down the ion guns or raising the sample into the airlock. A Stereo Optical Microscope 40X, 80X magnification should be supplied along with the ion milling equipment as standard. Supplier to optionally offer CCD Camera based real time sample viewing system with PC & appropriate software for image capture as optional item as optional accessory. Remote access to the system must be available through a network connection. The communication protocols will be used for monitoring the system's status, starting, pausing, and/or stopping the milling process. Work chamber base pressure should preferably be: ~1E –6 Torr. Suitable gauges to monitor the vacuum levels in main chamber and baking pump. The system shall be air cooled only, no water cooling should be required. All required accessories should be provided. All consumables should be supplied for 5 years from installation free of cost.
39.	Ultrasonic Disk Cutter	Preferable specifications: Circular cutting tool 3 mm, 2.3 mm diameter, Rectangular cutting tools 4mm X 5mm and/or bigger, should have stereo microscope for sample alignment, depth of cut indicator is preferred. All required accessories should be provided. All consumables should be supplied for 5 years from installation free of cost.
40.	Disk Punch	Preferable specifications: - Should be able to cut 3 mm diameter circular samples from ductile and soft materials - Should be able to cut discs from samples with thickness from 60 µm to 100 µm or more

		- Should deliver discs with sharp edges - Horizontal cutting action is preferred All required accessories should be provided. All consumables should be supplied for 5 years from installation free of cost
41	Disk grinder, lapping kit	Preferable specifications: Disc mount with goniometer with at least 10 micron graduation on the scale (automated operation is preferred) - Specimen lapping kit with at least 2 heavy metal base, and at least 5 ultra-flat glass lapping plates: and approximately 100 lapping discs for each grit size - Specimen mounting hot plate and low melting polymer wax rods - All necessary consumables, for an uninterrupted operation during warranty period, including SS and Pyrex specimen mounting cylinders and mounting wax shall be supplied All required accessories should be provided. All consumables should be supplied for 5 years from installation free of cost.
42.	Dimple grinding unit	Preferable specifications: - Specimen positioning should be precise with the help of microscope and specimen stage - Operational facilities: table rotation, grinding wheel rotation, variable grinding wheel speed, auto terminator for both grinding wheel and specimen rotation motor, variable grinding load - Specimen platen speed - minimum 5 rpm or better - Dimpling should reduce the thickness of the disc (in the central region) to 10 microns or less, with no or minimum damage. - Automatic termination of the process. - A stereomicroscope, to align the specimen position is preferred -All required accessories should be provided. All consumables should be supplied for 5 years from installation free of cost.
43.	Cross-sectional TEM Kit	Preferable specifications: Complete cross sectional specimen preparation kits for thin films and multilayers should be provided with all the required accessories. Specimen mounting hot plate should be provided with temperature control. All consumables should be supplied for 5 years from installation free of cost.
44.	Jet Polisher	Preferable specifications: The automatic electrolyte jet thinning equipment should be able to prepare a specimen of 3mm diameter for TEM having thickness less than 50nm.The thinning unit should consist of a control unit, polishing unit. Should have an electronic thermometer to measure temperature of the electrolyte. All required accessories should be provided. All consumables should be supplied for 5 years from installation free of cost. This item may be quoted separately.

45.	Diamond Saw	Preferable specifications: Precision slow speed cutter with vernier; regular and irregular shape sample fixture assembly; ~ 125 mm dia. Diamond wafering blade (10 Nos.); ~ 75 mm dia. Diamond wafering blade (10 Nos.); Low speed cutting fluid (10 Ltrs); Dressing sticks (20 Nos.).All consumables should be supplied for 5 years from installation free of cost.
46.	Installation/ power requirements	All the prerequisites for installation of sample preparation facilities have to be quoted. Institute will only provide electricity at single or three phase 220V, 50Hz, normal quality water and space. Vendor also should quote for suitable UPS and other required accessories to run the TEM sample prep equipment smoothly. The vendor has to submit pre-installation site requirements/guidelines for the entire TEM sample prep lab equipment along with the technical bid.
37.	Compliance Statement	The supplier must submit a table indicating the compliance of the features of the model of the equipment being quoted with those given in the indent (for section B). Features not matching – must be clearly indicated. Additional features and features in the quoted equipment which are better than those in the indent – may be clearly explained. The supplier must submit technical brochures and proper application notes adequately explaining and confirming the availability of the features in the model of the equipment being quoted.

48.	Warranty, AMC Training and Service Support For section A and B	On-site training for at least 4 week for TEM/STEM, tomography, cryo/heating holder, EELS and sample preparation (atleast 1 week for sample preparation alone), in addition to different software features should be provided to the users by the vendor's trained engineers at the convenience of IISER Mohali, after the satisfactory installation of the instrument and its accessories. Advanced training may be provided in factory to 2-3 person from IISER-M if required. Necessary documents, operational & system manual in the form of CD and hardcopy for all equipments and accessories must be supplied with the system. Service response time, turn-around time & up-time of the equipment should be clearly specified. Service response time must be less than 72 hours. The TEM must have provision for on-line diagnosis of faults. Suitable service facility for computer hardware or software related problems should also be provided. Upgradation of all the software has to be supplied free of cost as and when it is upgraded within 10 years of microscope supply. The spare parts should be available up to 10 years from the date of installation.

		For section A: Five years comprehensive on-site warranty should be offered for entire offered configuration (after successful commissioning of the equipment). Annual Maintenance Contract (AMC) for 3 years, after 5 years warranty period is over, should be quoted separately. For section B: Three years comprehensive on-site warranty should be offered for entire offered configuration (after successful commissioning of the equipment). Annual Maintenance Contract (AMC) for 2 years, after 3 years warranty period is over, should be quoted separately.
49.	Tool kit	Suitable and essential tool kit is to be supplied with the system for the required maintenance for all the items in section A, B.
50.	Installation and commissioning	The supplier should undertake to install and commission all equipments and all attachments accessories mentioned in Section A and B and also demonstrate their performance guaranteed as per specifications at site free of cost. The items in section B should be supplied after a month of commissioning of items in section A. The training of the same should commence after one month of supply.