

## Appendix-I

Sr. No.	Name of Item with specification	Qty.
1	<p><b><u>Three hinged arch:</u></b></p> <ol style="list-style-type: none"> <li>1. At least one symmetrical steel/aluminium arch specimen of a minimum span of 0.80 m and a minimum rise of 0.20 m should be supplied.</li> <li>2. An option should be provided for unsymmetrical arch specimen by suitable modifications in symmetrical arch specimen.</li> <li>3. The apparatus should be capable for demonstration of different types of loads (point load, uniformly distributed load, moving load).</li> <li>4. A set of weights should be supplied for a minimum total weight of 50 N which can be useful for application for uniformly distributed and point loads. Furthermore, a moving load system comprising of a minimum of two interconnected weights of 10 N each (1 no.) should be supplied.</li> <li>5. The support reactions (horizontal as well as vertical) should be measured through integrated load cells. Each load cell should have a minimum capacity of 500 N and should connect a data acquisition and display interface.</li> </ol>	01 Unit
2	<p><b><u>Plastic bending of beams:</u></b></p> <ol style="list-style-type: none"> <li>1. At least two beam specimens (one made from steel and another from aluminium) of a length between 0.8 m to 1.2 m) and having different cross-sections should be provided.</li> <li>2. A screw jack loading mechanism with an integrated load cell of a minimum 500 N capacity should be supplied.</li> <li>3. Provision for measurement of collapse load shall be available.</li> <li>4. The simply supported and fixed conditions should be simulated at the end supports of the beams.</li> <li>5. A digital dial gauge having suitable mounting arrangement should be given. The gauge should have a measurement range of 0 - 15 mm or better and a resolution of 0.01 mm or better.</li> <li>6. The dial gauge and the loading jack should connect to a data acquisition and display interface to measure the deflection and applied load/collapse load at a minimum resolution of 0.01 mm and 0.1 N respectively.</li> </ol>	01 Unit

3	<p><b><u>Deflection of frames:</u></b></p> <ol style="list-style-type: none"> <li>1. At least one rectangular portal frame of steel having different cross sections for beams and columns should be supplied. Minimum horizontal span and height of the specimen should be 0.5 m.</li> <li>2. The apparatus should include tools and accessories for the demonstration of vertical as well as horizontal loads.</li> <li>3. The apparatus should include tools and accessories for the creation of the simple (hinged and roller) and fixed supports at the base of the frame.</li> <li>4. The support reactions (horizontal as well as vertical) and moments should be measured through integrated load cells. Each load cell should have a minimum capacity of 500 N.</li> <li>5. A minimum of three calibrated load hangers should be provided. At least twenty calibrated weights ranges from 0.1 N to 50 N should be given.</li> <li>6. At least two digital dial gauges with suitable mounting arrangement should be supplied for the measurement of deflection and sway. The gauge should have a measurement range of 0 - 15 mm or better and a resolution of 0.01 mm or better.</li> <li>7. The dial gauges and load cells should connect to a data acquisition and display interface to measure the deflection, reactions and moments at a minimum resolution of 0.01 mm, 0.1 N and 0.1 Nm respectively.</li> </ol>	01 Unit
4	<p><b><u>Continuous and indeterminate beams:</u></b></p> <ol style="list-style-type: none"> <li>1. At least two beam specimens (one made from steel and another from aluminium) of a length between 0.8 m to 1.2 m) and having different cross-sections should be provided. The beam specimens are in addition to provided in the previous apparatuses. The beam specimens should have cross-sections with respect to provide in the previous apparatuses.</li> <li>2. The simply (hinged and roller) supported and fixed conditions should be simulated at the supports of the beams. The supports should be allowed to sink.</li> <li>3. The simply supported beams, fixed beams, cantilever beams, propped cantilever beams, overhanging beams. Two and three span continuous beams should be created by changing the support conditions.</li> <li>4. The apparatus also should be capable for demonstration of point loads and uniformly distributed loads through a set of calibrated hangers and weights.</li> <li>5. The apparatus should include at least two double pulley systems in order to apply the point loads on the beam.</li> </ol>	01 Unit

	<ol style="list-style-type: none"> <li>6. At least three digital movable dial gauges should be provided. The gauges should have a measurement range of 0 - 15 mm or better and a resolution of 0.01 mm or better.</li> <li>7. The dial gauges should connect to a data acquisition and display interface to measure the deflection at a minimum resolution of 0.01 mm.</li> <li>8. At least four integrated load cells mounted on piers should provide in order to measure the support reactions (horizontal as well as vertical) and fixed end moments. Each load cell should have a minimum capacity of 500 N and should connect a data acquisition and display interface.</li> </ol>	
5	<p><b><u>Shear force and bending moment in beam:</u></b></p> <ol style="list-style-type: none"> <li>1. At least two beam specimens of simply supported beams (one made from steel and another from aluminium) of a length between 0.8 m to 1.2 m) and having different cross-sections should be provided. The beam specimens are in addition to provide in the previous apparatuses. The beam specimens should have different cross-sections with respect to provide in the previous apparatuses.</li> <li>2. The apparatus also should be capable for demonstration of point loads and uniformly distributed loads through a set of calibrated hangers and weights.</li> <li>3. At least two load cells should provide in order to measure the shear force and bending moment. One load cell should attach with underslung moment arms. Each load cell should have a minimum capacity of 500 N and 500 Nm and should connect a data acquisition and display interface.</li> </ol>	01 Unit
6	<p><b><u>Beam deflection:</u></b></p> <ol style="list-style-type: none"> <li>1. At least two beam specimens (one made from steel and another from aluminium) of a length between 0.8 m to 1.2 m) and having different cross-sections should be provided. The beam specimens are in addition to provided in the previous apparatuses. The beam specimens should have different cross-sections with respect to provided in the previous apparatuses.</li> <li>2. The simply supported beams, fixed beams and cantilever beams should be created by changing the support conditions. The apparatus also should be capable for demonstration of point loads and uniformly distributed loads through a set of calibrated hangers and weights.</li> <li>3. At least three digital movable dial gauges should be provided. The gauges should have a measurement range of 0 - 15 mm or better and a resolution of 0.01 mm or better.</li> </ol>	01 Unit

	<p>4. The dial gauges should connect to a data acquisition and display interface to measure the deflection at a minimum resolution of 0.01 mm.</p>	
7	<p><b><u>Deflection of curved bars:</u></b></p> <ol style="list-style-type: none"> <li>1. A set of cantilever specimens (minimum Six) having different geometry and materials should be provided.</li> <li>2. At least two dedicated hangers along with calibrated weights should be supplied. At least twenty calibrated weights ranges from 0.1 N to 50 N should be given.</li> <li>3. At least two digital dial gauges with suitable mounting arrangement should be supplied for the measurement of deflection. The gauge should have a measurement range of 0 - 15 mm or better and a resolution of 0.01 mm or better.</li> <li>4. The dial gauges should connect to a data acquisition and display interface to measure the deflection at a minimum resolution of 0.01 mm.</li> </ol>	01 Unit
8	<p><b><u>Pin jointed frames :</u></b></p> <ol style="list-style-type: none"> <li>1. At least one truss system with different geometry arrangement of pin jointed members (steel or aluminium) should be supplied. The system should include of a minimum of eleven members constituting a horizontal span of at least 0.8 m.</li> <li>2. Each member of the pin jointed frame should have a strain gauge attachment to facilitate the measurement of induced axial strains.</li> <li>3. The apparatus should provide hinged and roller support conditions.</li> <li>4. A minimum of one screw jack loading system with integrated load cells of the capacity of 500 N or higher should be provided.</li> <li>5. The support reactions (horizontal as well as vertical) should be measured through integrated load cells. Each load cell should have a minimum capacity of 500 N and should connect a data acquisition and display interface.</li> <li>6. A movable digital dial gauge with suitable mounting arrangement should be provided for the measurement of the joint deflections. The gauge should have a measurement range of 0 - 15 mm or better and a resolution of 0.01 mm or better.</li> <li>7. The strain gauges, dial gauge, load cells should connect to a data acquisition and display interface to measure the strain, deflection and applied load at a minimum resolution of 0.1 <math>\mu</math>, 0.01 mm and 0.1 N respectively.</li> </ol>	01 Unit

9	<p><b><u>Equilibrium of forces :</u></b></p> <ol style="list-style-type: none"> <li>1. The apparatus should be capable to study at least six concurrent and non-concurrent forces in two-dimensional vertical plane.</li> <li>2. The apparatus should include at least six pulleys and nylon cords (minimum length 50 m).</li> <li>3. At least six dedicated hangers along with calibrated weights should be supplied. At least twenty calibrated weights ranges from 0.1 N to 50 N should be given. The arrangement should be included for the attachment of cords and load hangers at each end.</li> <li>4. One soft board and 100 clips should be included in order to facilitate indicating the lines of action for the experimentations by the students.</li> </ol>	01 Unit
10	<p><b><u>Universal frame and stand:</u></b></p> <ol style="list-style-type: none"> <li>1. At least two floor mounted frames having a minimum internal working size of 1.2 m length and 0.75 m height should be supplied.</li> <li>2. A kit should be included to convert the frame into table/bench mounted frame.</li> <li>3. The each member of the frames should be made of corrosion and wear resistant material.</li> <li>4. The tools and accessories required to assemble and disassemble the frame should be supplied.</li> <li>5. The assembled frame should provide for easy mounting of all test hardware.</li> <li>6. The assembled frame should remain stable under loading and should have a minimum load carrying capacity of 5000 N.</li> </ol>	02 Unit
11	<p><b><u>Data acquisition system:</u></b></p> <ol style="list-style-type: none"> <li>1. The data acquisition systems shall facilitate capture and storage of data and will act as an interface between experimental setup and the software.</li> <li>2. The interface shall allow for quick and easy connection to experiment</li> <li>3. The data acquisition system should comprise the data acquisition hardware, its compatible software and latest computer system. Compatibility between software and data acquisition system should be ensured.</li> </ol>	01 Unit

	<ol style="list-style-type: none"><li>4. The software should be installed in the computer system and supplied in CD. It should be compatible and capable of simulating the particular experiment on a Windows based computer platform. It should produce tabular and graphical display of the different parameters.</li><li>5. Software shall have capability to measure and display parameters in different unit systems like SI, MKS, CGS etc. Provision of exporting data files to excel and other formats shall be available.</li><li>6. Software shall be compatible for data transfer with any external data acquisition system.</li><li>7. The data acquisition and display interface should have a minimum of four input channels for measurement of load, strains etc. In order to ensure smooth working and avoid data loss during power cuts, the instrument shall be supplied with universal power supply.</li><li>8. The computer system should have following minimum requirements:<ol style="list-style-type: none"><li>(a) All-in-one-desktop with i7 processor and Windows 10 operating system</li><li>(b) 23.8-inch screen monitor with Intel HD Graphics</li><li>(c) 8GB DDR3L RAM</li><li>(d) 1TB hard drive</li><li>(e) 3 USB 3.0 ports</li></ol></li></ol>	
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