The following table contains the requested items for CEE in the format requested by the Dean’s office. The amount requested, $187,297, is approximately the same as the amount allocated to CEE ($187,200). The prioritized list of requests is shown on page 3 of this document and more detailed descriptions of each request are given starting on page 4. Notice that some of the items in the prioritized list had to be broken down in the table below to fit the format requested by the Dean’s office. In every case, however, the specific items requested in each line item have been referenced to the appropriate item and page in the more detailed description section of the document. Unless otherwise noted, 100% undergraduate use is assumed. The requested funds will be matched with $2,600 from other sources to account for non-undergraduate student use.

### Lab. Equipment > $5,000 (itemize each piece of equipment, lab and function)

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Requested Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotechnical Lab – Automated Direct Shear System (Item 17, page 5)</td>
<td>$25,000</td>
</tr>
</tbody>
</table>

### Regular Personal Services

- Technician assistance - One laboratory/equipment technician in addition to general funds department technicians (Item 27, page 7) | $50,000 |
- Teaching assistants/graders for laboratory classes (Item 28, page 7) | $40,000 |

**Total Lab Equipment > $5,000 and Regular Personnel Services** | $115,000 |

### Casual Hires (specify function)

**Total Casual Hires** | $0 |

### Student Assistants (specify the labs)

**Total Student Assistants** | $0 |

### Lab. materials and supplies and lab operations (specify the labs)

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Requested Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Lab – Materials and supplies for CEE 330 (items 4-14, pages 4-5)</td>
<td>$4,897</td>
</tr>
<tr>
<td>Geotechnical Lab – CEE 355-455 Materials, supplies, and safety equipment (Item 15, page 5)</td>
<td>$2,000</td>
</tr>
<tr>
<td>Concrete Lab – Materials and Supplies for CEE 375 (annual basis) (Item 1, page 4)</td>
<td>$2,000</td>
</tr>
<tr>
<td>Structures and concrete materials lab – Materials, supplies, and safety equipment for CEE 370, CEE 375, and CEE 485 (Item 24, page 7)</td>
<td>$8,000</td>
</tr>
<tr>
<td>Pavement lab – Material, supplies, and safety equipment for CEE461 (Item 22, page 7)</td>
<td>$2,000</td>
</tr>
</tbody>
</table>

**Total Lab materials and supplies and lab operations** | $18,897 |

### Equipment and Furniture Repairs & Maintenance

- Structures lab – Equipment maintenance (Item 25, page 7) **(Matching funds)**
### CEE List of Undergraduate Laboratory Needs

**Fall 2011 – 11-14-2011**

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>$600)...........................................................................................................</td>
<td>$ 5,400</td>
</tr>
<tr>
<td>Vacuum for CEE 144 (item 30, page 7) ..................................................................</td>
<td>$ 200</td>
</tr>
<tr>
<td>Repair and upgrade of the wavemaker for the large wave tank in the CEE hydraulics lab (item 19, page 6)</td>
<td>$ 15,000</td>
</tr>
<tr>
<td>Replacement Projector Screen for Room 287 (item 34, page 8) ..................................</td>
<td>$ 4,200</td>
</tr>
<tr>
<td>Shop – Network PTZ High Def. Camera (item 31, page 8) ........................................</td>
<td>$ 2,700</td>
</tr>
<tr>
<td>Network Time Clocks (item 32, page 8) ....................................................................</td>
<td>$ 3,500</td>
</tr>
<tr>
<td>Replacement Cabinets for Instrumentation Room (off structures lab, item 33, page 8)</td>
<td>$ 8,000</td>
</tr>
<tr>
<td><strong>Total Equipment and Furniture Repairs and Maintenance</strong> ..................................</td>
<td>$ 39,000</td>
</tr>
<tr>
<td><strong>Computer Repairs &amp; Maintenance</strong> ......................................................................</td>
<td>$ 0</td>
</tr>
<tr>
<td><strong>Total Computer Repairs &amp; Maintenance</strong> .......................................................</td>
<td>$ 0</td>
</tr>
<tr>
<td><strong>Computer Software</strong> .........................................................................................</td>
<td>$ 0</td>
</tr>
<tr>
<td><strong>Total Computer Software</strong> ................................................................................</td>
<td>$ 0</td>
</tr>
<tr>
<td><strong>Computer Software License Fees</strong> ......................................................................</td>
<td>$ 3,000</td>
</tr>
<tr>
<td>Senior Design Studio lab – Civil 3D licenses renewal (item 29, page 7) ..................</td>
<td>$ 3,000</td>
</tr>
<tr>
<td><strong>Total Computer Software License Fees</strong> ............................................................</td>
<td>$ 3,000</td>
</tr>
<tr>
<td><strong>Lab. Equipment for controlled Property (computers, etc., each with price tag of &lt;$5,000)</strong></td>
<td>$ 14,000</td>
</tr>
<tr>
<td>Hydraulics lab: Pressure gage and valve for CEE320 class (item 18, page 6) ...........</td>
<td>$ 2,000</td>
</tr>
<tr>
<td>Concrete/Pavement Lab: Ro-Tap® Sieve Shaker with Sound Enclosure and Test Stand (item 23, page 7)</td>
<td>$ 4,000</td>
</tr>
<tr>
<td>Concrete Lab – Concrete mixer, MARSHALLTOWN, The Premier Line MIX49172 3</td>
<td>$ 2,300</td>
</tr>
<tr>
<td>Cubic Foot 1/2-Horsepower Electric Cement Mixer or similar (Item 2, page 4) ............</td>
<td>$ 2,200</td>
</tr>
<tr>
<td>Concrete Lab - Mortar Mixer: Hobart Corporation N50-60 - Countertop Mixer, 5 Qt, 3 Speed or similar (Item 3, page 4)</td>
<td>$ 1,000</td>
</tr>
<tr>
<td>Transportation Lab – PC Monitors and Software (item 20, page 6) (Matching funds $2,000)</td>
<td>$ 2,500</td>
</tr>
<tr>
<td>Shop – Network PTZ High Def. Camera (item 31, page 8) ........................................</td>
<td>$ 2,500</td>
</tr>
<tr>
<td><strong>Total Lab. Equipment for controlled Property (&lt;$5,000)</strong> ..................................</td>
<td>$ 14,000</td>
</tr>
</tbody>
</table>
**Prioritized list of CEE undergraduate laboratory needs**

The list below is an assessment of equipment needs for the undergraduate CEE labs as of the Fall semester of 2011.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Env. Lab – Materials and supplies for CEE 330 (items 4-14, page 4 and 5)</td>
<td>$4,897</td>
</tr>
<tr>
<td>2.</td>
<td>Geotechnical Lab – CEE 355-455 Materials, supplies, and safety equipment (item 15, page 5)</td>
<td>$2,000</td>
</tr>
<tr>
<td>3.</td>
<td>Concrete Lab – Materials and Supplies for CEE 375 (annual basis) (Item 1, page 4)</td>
<td>$2,000</td>
</tr>
<tr>
<td>4.</td>
<td>Concrete Lab – Concrete mixer, MARSHALLTOWN, The Premier Line MIX49172 3 Cubic Foot 1/2-Horsepower Electric Cement Mixer or similar (Item 2, page 4)</td>
<td>$2,300</td>
</tr>
<tr>
<td>5.</td>
<td>Concrete Lab - Mortar Mixer: Hobart Corporation N50-60 - Countertop Mixer, 5 Qt, 3 Speed or similar (Item 3, page 4)</td>
<td>$2,200</td>
</tr>
<tr>
<td>6.</td>
<td>Structures and concrete materials lab – Materials, supplies, and safety equipment for CEE 370, and CEE 485 (item 24, page 7)</td>
<td>$8,000</td>
</tr>
<tr>
<td>7.</td>
<td>Pavement Lab – Material, supplies, and safety equipment for CEE461 (item 22, page 7)</td>
<td>$2,000</td>
</tr>
<tr>
<td>8.</td>
<td>Hydraulics lab – Pressure gage and valve for CEE320 class (item 18, page 6)</td>
<td>$2,000</td>
</tr>
<tr>
<td>9.</td>
<td>Technician assistance (item 27, page 7)</td>
<td>$50,000</td>
</tr>
<tr>
<td>10.</td>
<td>Teaching assistants/graders for laboratory classes (item 28, page 7)</td>
<td>$40,000</td>
</tr>
<tr>
<td>11.</td>
<td>Structures lab – Equipment maintenance (item 25, page 7)</td>
<td>$6,000</td>
</tr>
<tr>
<td>12.</td>
<td>Senior Design Studio lab – Civil 3D licenses renewal (item 29, page 7)</td>
<td>$3,000</td>
</tr>
<tr>
<td>13.</td>
<td>Concrete/Pav. Lab – Sieve Shaker w/Sound Encl. and Stand (item 23, page 7)</td>
<td>$4,000</td>
</tr>
<tr>
<td>14.</td>
<td>Vacuum for CEE 144 (item 30, page 7)</td>
<td>$200</td>
</tr>
<tr>
<td>15.</td>
<td>Transportation Lab – PC Monitors and Software (item 20, page 6) (requires $2,000 matching funds)</td>
<td>$3,000</td>
</tr>
<tr>
<td>16.</td>
<td>Repair and upgrade of the wavemaker for the large wave tank in the CEE hydraulics lab (item 19, page 6)</td>
<td>$15,000</td>
</tr>
<tr>
<td>17.</td>
<td>Geotechnical Lab – Automated Direct Shear System (Item 17, page 5)</td>
<td>$25,000</td>
</tr>
<tr>
<td>18.</td>
<td>Replacement Projector Screen for Room 287 (item 34, page 8)</td>
<td>$4,200</td>
</tr>
<tr>
<td>19.</td>
<td>Shop – Network PTZ High Def. Camera (item 31, page 8)</td>
<td>$2,700</td>
</tr>
<tr>
<td>20.</td>
<td>Network Time Clocks (item 32, page 8)</td>
<td>$3,500</td>
</tr>
<tr>
<td>21.</td>
<td>Replacement Cabinets for Instrumentation Room (off structures lab, item 33, page 8)</td>
<td>$8,000</td>
</tr>
<tr>
<td>22.</td>
<td>Structures lab – Replacement TestStarII controller (item 26, page 7)</td>
<td>$50,000</td>
</tr>
<tr>
<td>23.</td>
<td>Automated Loadframe Testing Systems For CEE 355 Teaching Laboratory (item 16, page 5)</td>
<td>$50,000</td>
</tr>
<tr>
<td>24.</td>
<td>Transportation Lab – Chairs (item 21, page 6)</td>
<td>$1,500</td>
</tr>
<tr>
<td>25.</td>
<td>Concrete, Pav. and Structures Labs – Mezzanine Build-out (item 35, page 8)</td>
<td>$1,500,000</td>
</tr>
</tbody>
</table>

Total items 1-21 ........................................................................................................ $189,897

Minus matching funds contribution ......................................................................... $2,600

**Current allocation to undergraduate laboratory needs from lab fees** ....................... $187,297

Plus emergency funds for undergraduate equipment needs ................................... $-97

**Total fees allocated to CEE** ................................................................................ $187,200

**Current undergraduate laboratory needs** ............................................................... $1,791,397
Concrete Laboratory (CEE 375 and Concrete Canoe Team)

1. Materials and Supplies (annual basis): fine aggregate pycnometers, disposable trays, paper towels, spatulas, spoons, test supplies, equipment maintenance, etc.
   $2,000/year

2. Concrete mixer, MARSHALLTOWN The Premier Line MIX49172 3 Cubic Foot 1/2-Horsepower Electric Cement Mixer or similar. Our only working concrete mixture stopped working for 10-min when mixing a stiff concrete mix in CEE375 Lab. The torque is too low.
   $2,300

3. Mortar Mixer: Hobart Corporation N50-60 - Countertop Mixer, 5 Qt, 3 Speed or similar. When I was helping our concrete canoe team mixing trial mixes, the torque of our mortar mixer (used for Kitchen) was so low that I stopped it use a finger.
   $2,200

Environmental Lab

All for CEE 330 – reqd. class offered every semester w/2 sec. @ 20 max. ea.

4. Cartridges for water purification system
   1 set $1,035.00 Cartridges for the water purification system $1,050/set. Use 2 sets/year.
   $2,100/year

5. Analytical Balance calibration
   $60/balance. Actively use 3 balances.
   $180/year

6. Safety materials:
   a. disposable aprons $80/100. Use 100/year
   b. gloves $25/100. Use 100/year
   c. goggles $4.00 each. Use 60/year
   d. antimicrobial hand soap $70/gallon. Use 1 gallon/year
   e. table top disinfectant $110/gallon. Use 1 gallon/year
   f. autoclave bags $258/200. Use 200/year
   $823/year

7. Chemicals such as sodium hydroxide, hydrochloric acid, etc.
   $500/year

8. Replacement of glassware
   $500/year

9. Bacterial agar $66/100g. Use 100g/year.
   $60/year

$130/year

11. Glass fiber filters $45/100. Use 400/year.
   $180/year

12. 0.45um filters $139/100. Use about 150/year
   $209/year

   $130/year

14. HACH powder pillows $28.25/100. Use 300/year.
   $85/year

TOTAL for Environmental Lab: $4,897

Geotechnical Lab (CEE 355)

15. Materials and Supplies (annual basis): chemicals, trays, spatulas, spoons, sieves, glassware, equipment maintenance, etc.
   $2,000/year

16. Automated Loadframe Testing Systems For CEE 355 Teaching Laboratory
   We currently conduct two CEE 355 laboratory sessions (consolidation and unconfined compression strength) using highly outdated equipment that is also unreliable and cumbersome. Data is collected by hand and this limits the amount of information that can be obtained per test. Students are not exposed to essential knowledge regarding transducers, calibration of transducers, data acquisition software, and data processing.
   We typically have four groups of students in each lab session and therefore aim to have four sets of each testing system available for instruction.
   We are requesting the purchase of 4 Automated Loadframe Testing Systems, including loadframe, consolidation cells, all necessary transducers, data acquisition computers, and software. These will be used every semester as the principal equipment in two laboratory experiments. Every civil engineering undergraduate student is required to take CEE 355.
   $50,000

17. Automated Direct Shear System: This equipment will replace our 20 years+ old manual direct shear apparatus that is used every semester as the centerpiece of our direct shear test lab session. The current equipment is outdated, the data quality is awful, and it is almost impossible to obtain replacement parts. Students need to be exposed to computer-controlled testing systems and modern data acquisition and processing software. This testing system incorporates all of these aspects without being unduly complicated. The equipment will be used exclusively for undergraduate instruction (CEE 355). Eventually we would like to purchase two or more of these so that lab groups (typically 4) can work in parallel rather than sequentially.
   Total request: $25,000 for the first system and an additional $75,000 for the other three systems in future years.
Hydraulics lab - CEE320, CEE421 (open channel flow) and graduate courses:

The main undergraduate teaching activities in this lab are the CEE320 experiments. In addition, other courses including CEE421 and some graduate courses (fluid mechanics, ground water hydrology) also use the lab for one or two experiments or demos from time to time.

Requests:

18. Pressure gage and valve for CEE320 class: (Michelle Teng)
   Lab experiments on energy loss through a valve. The current set does not work anymore and needs to be replaced.
   $2000

19. Repair and upgrade of the wavemaker for the large wave tank in the CEE hydraulics lab
   Uses:
   a) ME213 class: (Reza Ghorbani) student design projects on wave energy conversion devices
   b) Graduate student thesis and research
   c) Open house/outreach activities
   $15,000

Traffic and Transportation lab

20. PC Monitors and software for TTL (Holmes 353) including: Two 27” PC monitors ($500 each),
   Five 22-24” PC monitors ($300 each), Three Acrobat Pro ($150 each) including shipping and handling. Undergraduate/Graduate share: 33%/67%.
   TTL monitors are over six years old. Two of the six are flickering. It’s time for a replacement. Depending on final pricing, one or two larger monitors will be ordered to make simulation and Autoscope demonstrations easier. Also the graduate students at TTL requested copies of Adobe Acrobat Professional. I (Prevedouros) too need one, so in total 3 copies are requested.
   TTL PCs are used extensively for graduate course instruction, graduate student research, research projects, demonstrations to undergraduates and demonstrations to over 100 visitors per year. It is important to have well functioning PCs and monitors.
   Almost all graduate courses in transportation are instructed in the TTL, and when an undergraduate course is smaller than 15 students it may be moved to TTL. This occurred for CEE 462 in Spring 2010.
   Total request amount: $3,000.00.

21. The chairs at the Traffic and Transportation lab (TTL) are decapitated and need replacement.
   Past purchases in the $30-$50 range proved to be poor choices as the chairs begin to sag or break after one or two years of use.
   Ten (10) office chairs priced in the $100 to $150 for better comfort and longevity, thus the requested budget is $1,500.
Pavement Laboratory (CEE 461)

22. Materials and Supplies (annual basis): heat resistant globes, nitrile globes, asphalt emulsifier (for cleaning instruments), filter papers, disposable trays, paper towels, construction paper, spatulas, spoons, mixer whip, aggregate, asphalt cement, test supplies, sieves, gyratory molds, mixer bowl, glassware, equipment maintenance, etc.
   $2,000/year

23. SS-31 12in Ro-Tap® Sieve Shaker with Sound Enclosure and Test Stand. The sieve shaker holds up to eight half-height sieves and pan. Recommended particle size range is 1/2in (12.5mm) to No.500.
   $4,000

Structures Laboratory

24. Materials, Supplies and safety equipment required on an annual basis: (Essential for undergrad laboratory sessions.)
   CEE370 - $3,000 (Metal test specimens, strain gages, beam test specimens, etc.)
   CEE485 - $5,000 (Reinforcing steel, formwork, concrete, placement equipment, etc.)

25. Equipment maintenance required on an annual basis: (Required for equipment used in undergrad laboratories and research)
   Calibration of load cells and extensometers - $6,000 per annum.

26. Replacement TestStarII controller for hydraulic test system in Structures Laboratory - $50,000. For the past 6 years we have had two controllers capable of running the test system. Failure of one controller meant we could still run the laboratory tests. However, the older (1995) controller has now failed and is beyond repair. We are running on the second (2004) controller. Any failure of this controller could shut down laboratory testing for 2 to 3 months while it is shipped to the mainland for repair, as second controller is required to avoid downtime for the laboratory experiments.

Other:

27. Technician assistance - One laboratory/equipment technician in addition to general funds department technicians - $50,000/year.

28. Teaching assistants/graders for laboratory classes (CEE375/CEE320/CEE355, etc.) $40,000/year.

29. Senior Design Studio lab
   12 Civil 3D licenses at $250 each (annual)
   $3,000.

30. Vacuum for CEE 144 - the Senior Design Studio lab
   It will allow the students to keep the room cleaner.
   $200
31. Network PTZ High Def. Camera
   For remote observation of experiments and security in hydraulics lab $2700

32. Network Time Clocks
   Replacement Wall Clocks (6x) for common use areas including classrooms, conference rooms and labs. Current clocks do not keep time accurately and some are inoperable. Network clocks are easily viewed from a distance, never need batteries, automatically set themselves and are always accurate. $3500

33. Replacement Cabinets for Instrumentation Room (off structures lab)
   Current cabinets had to be removed and demolished due to termite infestation. The new cabinets will be steel or other non-wood material $8000

34. Replacement Projector Screen for Room 287
   Current screen periodically malfunctions and screen surface has degraded & is dirty $4200

Concrete, Pavement, and Structures Labs

35. Mezzanine Build-out:
   The Asphalt, Concrete Materials, and Structures Labs are co-located in essentially one laboratory area. Space is very tight, and students have complained about the situation in the last exit interviews. Building a mezzanine over the area currently occupied by the Asphalt Materials and Concrete Materials labs will help to address partially this problem. The mezzanine will improve the learning environment for students during labs and research activities, as well as protect delicate and expensive equipment from damage during material staging. $1,500,000
Requests for non-undergraduate laboratory needs:

The following are requests listed separately since they are not related to undergraduate equipment needs. However, it is important to maintain a list should other funding become available.

The current list does not imply any type of prioritization.

**Hydraulics lab**

1. PC and LabView Data Acquisition System
   a. graduate student thesis and research
   b. general data acquisition system for any experiments conducted in the lab
   c. open house/outreach activities
   The existing system in the lab is from the year of 1995. This old system is broken down and no longer stable.
   $5,000 (PC and monitor: $1500; A/D converter, and LabView data acquisition system: $3,500)

2. High resolution video camera
   a. graduate student thesis and research
   b. general camera for recording any experiments conducted in the lab
   c. open house/outreach activities
   The existing video camera was broken by a high school intern when he dropped the camera to the floor from a high platform. It does not work anymore. The camera was purchased by the CEE department.
   $2000

3. FLUENT computer simulation software for fluid dynamics
   a. graduate student thesis and research
   b. summer research experiences (REU) for undergraduate students
   c. open house demos/outreach activities
   The annual licensing fee has been paid by the CEE department for the past four years.
   $3,800/year

**CEE 651**

1. LPILE V6.0
   The software is used by Dr. Ooi to teach CEE 651. It is a significant part of the lateral loading of single piles and drilled shafts portion of the course. This software is solely for teaching CEE 651.

   Dr. Ooi has LPILE V3.0 and has not upgraded in several years. The software requires a hard lock. The current hard lock we have consists of a parallel port dongle, which is clearly out of date. The last time the class was taught, no students had a laptop/computer with a parallel port. I had to provide an old laptop for students to use this software to do their homework (required) or term project (optional – their term project does not necessarily require LPILE but some choose to do an LPILE-based term project).
Total request $255.00

2. GROUP V8.0
   The software is used by Dr. Ooi to teach CEE 651. It is a significant part of the lateral loading of groups of piles and drilled shafts portion of the course. This software is solely for teaching CEE 651.

   Dr. Ooi has GROUP V7.0 and has not upgraded in several years. The software requires a hard lock. The software requires a hard lock. The current hard lock we have consists of a parallel port dongle, which is clearly out of date. The last time I taught the class, no students had a laptop/computer with a parallel port. I had to provide an old laptop for students to use this software to do their homework or term project.

   Total request $355.00

CEE 677 and Structural Health Monitoring Research

   1. Precision V/I Clamp 1 Channel
      The listed item is immediately needed for both research and classroom use for the following reasons:

      Precise measurements of analog and digital signals are frequently needed for current research project on self-sustainable sensing technologies.

      In this project, we are developing technologies for collecting energy from the environment to provide electrical power supplies of sensors. A multi-source solution is being sought for this problem. The energy sources considered include: vibration of structures and/or vortex induced vibrations of flexible objects (flags, trees, highly flexible space structures, etc.), solar, and electromagnetic wave in free space. Intensive theoretical and numerical investigations have been carried out with promising results. Several preliminary designs of device architecture have been obtained and are ready for experimental studies. NSF is currently supporting part of these activities, i.e. harvesting energy from vibrations of structures. The above listed current amplifier is requested so that accurate measurements of low-level current can be obtained. The supporting equipment has been acquired by an active NSF project, but the project does not have sufficient funds for the purchase of the amplifier. It is believed that research proposals seeking external research funds (NSF) will be developed based on the findings from experimental studies.

      The requested item will help revamp the lab sessions graduate course

      In CEE 677, advanced sensing, modeling, and control of structures are covered, which require a large amount of hands-on experiences in order for the students to understand modern concepts in smart structure technology. However, due to the lack of a good
data collecting equipment, the lab sessions have to be “light” – limited to some traditional experiments. If a current amplifier is available, many modern technologies can be included in the lab sessions, such as using wireless sensors for structural health monitoring, measuring vibration using photogrammic principles, etc. A greatly improved learning outcome will be achieved for this course.

The requested item will significantly benefit the ongoing research activities. It is a necessary tool for experimental study. The results obtained from experimental investigations will benefit the current funded research activities and will also lead to development of competitive research proposals for appropriate funding agencies.

The lack of the requested item will not only hamper the progress of the current research project, but will also make it impossible for the current unfunded activities to result in research proposals with high possibility of success.

The requested item will significantly benefit instructional efforts. It will immediately benefit one graduate class (CEE 677): more modernized laboratory experiments/demonstrations can be developed for the students.

The requested item may also be available for used in other courses if necessary.

The course covers some advanced topics in sensing, monitoring, modeling, control and dynamics. All of these topics require a great amount of hands-on experiences for the students to have a good understanding of modern theories and technologies. The requested item will greatly enhance the lab sessions of these courses, and thus drastically improve the learning outcomes. Without such item, the lab-session of the courses will remain “weak” and outdated.

Total request: $3407.00