

MECHATRONICS 2017 CONTEST

RULES, CONDITIONS AND SPECIFICATIONS

Professional Engineers Ontario Scarborough Chapter (PEOSC) conducted Mechatronics Car Contest (MCC) in the previous years as an introduction to Mechatronics, which is an upcoming multidisciplinary engineering field involving mechanical engineering, electrical engineering and ICT (information and communication technology). Robotics is a branch of Mechatronics. From this year (2017) PEOSC is introducing programming microcontrollers (such as Arduino) also into this contest, which will be held in smaller halls. Each year the project (contest devices) may be different.

The prizes are awarded in 2 categories:

1. ***Knowledge of participants determined by a panel of judges by interviewing***
2. ***Performance of the Mechatronics device(s) as determined by contest rules***

Steps to be followed by the participants:

- Register online → PEOSC will provide a program
- Debug the given program → PEOSC will provide components
- Build the Car and bring it to the competition venue
- Confirm the Registration on the day of event → Answer the Judges questions
- Run the car and win the race

Summary of Rules & Conditions

1. The contest is open for 2 Groups: **Juniors** (Grade 9 & 10) and **Seniors** (Grades 11 & 12) students of Scarborough High Schools.
2. Applications can be made by teachers or parents/guardian by filling the form on our website, and agreeing to the Rules and Conditions.
3. Each project (contest device) will be designed, fabricated and contested by Teams of 2 or 3 students.
Note: *Single student teams are not allowed.*
4. The work should be by the students only. Teachers and parents/guardians may coach/help the students, and **assure safety** during fabrication.
5. The students should fully understand their work as they will be judged by answering questions including practical measurements by using multimeters.
6. Parts will be supplied to the schools or parents from about few weeks before the contest.
 - a. Parent consent forms available at the site should be signed and submitted when receiving the parts.
 - b. A nominal registration fee of **\$ 15.00** per Junior Team and **\$ 20.00** per Senior Team is payable at the time of reception of parts. This fee is mainly to ensure that only interested students participate, and to partly offset the cost of parts.
7. Every participant will receive a Certificate of Participation.

Applying/Registering for Contest

Registration will commence about 1 month before the contest and will continue up to 2 weeks before the contest. Those who get the parts early can perform experiments and do the exercises including sample programming and learn mechatronics, mechanics and electronics to enhance their knowledge for their

future. The notes, guidelines, and exercises and programming tips will be available on our web-sites about 1 month before the contest.

Once the applications are received, PEOOSC will email a program with bug/s and the team will debug the program and email back to PEOOSC. Then we will supply some parts necessary for fabricating the project for the contest (List of parts supplied by PEOOSC are shown below). Contestants are expected to get the remaining parts required to complete assembling the project according to their own designs. Certain parts and methods are **mandatory** as detailed out in the specifications. They may use alternate parts and/or other parts for all other items in place of what is supplied. The contestants shall supply a cost estimate of all the parts used in the assembly. Lower cost, size and weight (if specified) of the fabricated project may be a favourable consideration for the prizes. Schools and Parents/Guardians may have to provide tools such as soldering irons, breadboards, glue guns, multi-meters for measurement and some workshop facilities.

Adult supervision and advice shall be required to ensure safe practices when using such tools.



1. Registration, Inspection and Interview by Judges

- Each team who registered at our website and accepted by PEOOSC will be supplied the listed parts and a team registration admission card on receipt of the registration fee and the parents' consent form: This will be from about 1 month to 2 weeks before the contest. The team shall present themselves personally, along with the admission card at the contest location on time with the fabricated project.
- The registered teams will pass through the **inspection** bay where the projects will be measured to check compliance with the specifications (length, width, height) and then weighed as required.
 - A panel of **judges** will then **interview** the contestants to test their presentation skills, and knowledge of their designs. The judges will go through the design notes, circuit diagrams, drive train diagrams and other documents that the contestant team brings. Also, the contestants will be asked to measure voltage, resistance or current in the circuits of their designs using analogue and/or digital multi-meters supplied by the judges, or brought in by the contestant.
 - Each contestant will have to answer a set of questions meant to test his/her knowledge of Mechanics, Electricity, Electronics and related fields.
 - The questions will be within the scope of the Ontario Curriculum plus some extras that is acquired by enthusiast hobbyists in this field. (Sample questions and answers will be available in our website at www.scarborough.peo.on.ca and follow the links for Mechatronics).

2. The Contest:

- After the interview, the project that was designed and fabricated by the team will be subject to performance testing. The performance is checked as per the Contest rules for the project for that year.

3. Prizes: (2 level each for Junior and Senior)

-  **3 prizes each for Junior team and Senior team (Judges)**
-  **3 prizes each for Junior team and Senior team (Performance)**

THE PROJECT

We will be giving notes and guidance in our website from 1 month before the contest to 2 weeks before the contest. These would be considered good enough for your projects. For additional reading and knowledge we give a set of reference books below:

Reference Books

*The following reference books are available in many Public and School libraries and bookstores and are recommended for reading. Certain Projects/sectioned given in *Italic* are very useful.*

For Both Junior and Senior Groups:

R1: For general reading: *Practical Electronics for Inventors*. Second or Third Edition – by **Paul Scherz – Publisher: McGraw-Hill. Year of Publication: 2nd Edition-2007, 3rd Edition - 2013. For general understanding of Electronics at all levels. Read only those applicable to your needs.**

R2: *Getting Started with Arduino: 3rd Edition* – The Open Source Electronics Prototyping Platform – by Massimo Banzi and Michael Shiloh

R3: *Mechatronics for the Evil Genius* – 25 build-it-yourself projects by **Newton C. Braga – Publisher: McGraw-Hill. Year of Publication: 2006. An idea of the Mechatronics Car and its circuitry may be obtained from Project 1 of the book.**

R4: *Arduino for Teens* by Robert W. and Kathleen M. Patterson

For Senior Group mainly:

R5: *Electronic Circuits for the Evil Genius, Second Edition* – 64 Lessons with Projects by **Dave Cutcher – Publisher: McGraw-Hill. Year of Publication: 2011. The additional features for the Senior Groups' cars can be learned from Sections 5, 6, etc. of the Book.**

Note: There are many differences in our Specifications, from those given in the books which require use of the contestants' knowledge of Mechanics, Electricity, Electronics, Science and Math. See our **Questions and Answers** link in our Web-site which gives **Guidelines, Notes, Questions and Answers for Students, Teachers, and Parents**. This link will be updated from time to time. Hence frequently refer to this. Other reference books will be posted in the web-site from time to time.

Materials/Components

Some parts required for the projects are available only at specialised shops and PEOSC have bought them in bulk at wholesale/discounted rates. Such parts for fabricating the project are supplied by PEOSC. The contestants shall bring detailed sketches and drawings along with design notes (Sample available in our web-site at www.scarborough.peo.on.ca and follow the links to Mechatronics: Guidelines, Notes, Exercises, Questions and Answers). Certain parts and methods are **mandatory** as detailed out in the specifications. They may use alternate parts and/or other parts for all other items in place of what is supplied as proposed in their design drawings and notes. PEOSC will supply some extra parts: resistors, capacitors, diodes, and transistors etc. for the contestants to experiment with and measure their characteristics using analogue and digital multimeters, to prepare for the judges interview.

Part supplied by PEO Scarborough Chapter: The following parts (valued at the discounted rates as \$15 for Junior Group and \$20 for Senior Group) are supplied by PEO SC.

Common for both Junior and Senior Groups:

1. Arduino UNO R3 microcontroller board.....	\$30.00
2. Half size Breadboard	\$5.00
3. 2 types of Battery holders for 4 AA batteries.....	\$2.50
4. 9V battery snap for connecting to the Battery holder.....	\$0.15
5. 2 Sets of 4 AA size alkaline batteries (8 Total, 4 for testing, 4 for the race).	\$2.00
6. 1 small 4.5-6V DC motor with specifications	\$1.50
Note: Only the one drive motor supplied by PEO SC shall be used in the project.	
7. 1 Darlington PNP transistor-TIP 120	\$0.75
8. Set of Resistors, capacitors, transistors, LEDs (For contestants to experiment and use what may be useful for the design). (Varies Average \$0.25 x4).....	\$1.00
9. Set of coloured wires for connections	\$ 0.20
10. Terminal strip/Circuit board	\$ 0.25
11. 2 ties.....	No cost
12. A set of gear wheels (10, 20, 30, 40, 50 teeth & bushings	\$2.00
13. A set of pulleys (10, 25, 38 & 50 mm diameter).....	\$ 1.00
Cost of all items supplied to Juniors.....	\$49.35
Tax (13%)	\$6.02
Total cost of all items supplied to Juniors	\$55.37

Additional parts for Senior Group

1. Choice of resistors and capacitors (varies Average \$0.10 x 10).....	\$1.00
2. Choice of additional LEDs	\$1.00
3. Printed Circuit board with plated holes at 0.1” spacing	\$2.50
Cost of additional items supplied to seniors only:.....	\$4.50
Cost of all items supplied to seniors:.....	\$53.85
Tax (13%)	\$7.00
Total cost of all items supplied to Seniors	\$60.85

Part/Items to be supplied by the Contestants: The contestants shall supply the following:

- Sketches/drawings of the designs, circuit diagrams, along with design notes (a sample available at our web-site). Drawings done using CAD programs are accepted, but no additional marks will be given. We expect good, clear freehand drawings or drawings done using compass, ruler and protractor. 3 D visualisation sketches are welcome.
 - Additional and alternative parts required to complete the project such as:
 - A model for the project made of cardboard, aluminum, plastic, Styrofoam or other material
 - Paint the project(optional)
 - Any additional parts required as per team’s design
 - Gear drive train or belt and pulley system if required (if different from the sets supplied)
 - Other parts as required as per contestants’ designs.
- Hint:** You may use parts from old toys and other sources.

Items Supplied/Provided by School/Teacher/Parents/Guardians: The following are expected to be supplied by School/Teacher/Parents/Guardians: **(Proper safety precautions including wearing of safety equipment have to be assured by an experienced teacher/parent/ guardian supervising or advising the fabrication).**

- Soldering iron/gun/station to be used in proper ventilated area, and adult supervision
- Additional Breadboards for experimenting and learning (optional)
- Solder and flux- Approved quality for electronic work
- **Note:** *Solderless construction using breadboards or other suitable methods are also acceptable.*
- Glue gun with glue sticks
- Tools and/or machinery for fabricating the project and the circuits
- Analogue Multimeter to learn to measure voltage, current and resistance
- Digital Multimeter to learn to measure voltage, current and resistance
- Single or double trace Oscilloscope (optional)
- Workshop facilities, if required.

SPECIFICATIONS FOR THE PROJECT

The contestants are required to adhere to the following specifications. The projects not meeting the specifications may be subject to disqualification.

Mandatory specifications:

1. The project shall not exceed a maximum dimension of: 300mm length, 150mm width and 200 mm height. This means that it should fit inside a box of 300 mm length, 150 mm width and 200 mm depth.
2. It shall be powered by **not more than 4 of AA** size alkaline batteries.
3. Only the **supplied 4.5 – 6 Volt DC motor** shall be used. **No other drive motor shall be used in the project.**
4. A suitable drive system consisting of **gears, pulleys, or direct drive or propeller fan** will be used in the project. A set of pulleys, gears and propeller will be supplied. You may choose from amongst these or supply/fabricate your own.
5. **For the Seniors:** Arduino program should be designed by the competitors and should be used in the flashing LED project. Other parts shall be resistors, capacitors, and LEDs. **Sketches/Drawings, and design notes etc.** shall be brought to the contest for the judges to inspect and question the contestants/teams. Hand drawn sketches, circuit diagrams are acceptable. Computer generated drawings/reports carry same credit as manual drawings/reports.
6. Each Project shall be given a **Name** which the team can display on the project body by printing, painting etc.

Optional specifications:

1. Parts not listed under **mandatory** may be changed for others of the contestant's choice. The use of alternate and/or additional parts shall be justified by the design notes or at the interview.
2. The contestants may select from the supplied set of pulleys, gears or propeller, or use their own alternative drive system. Readymade drive trains (from toys or other commercial products) will carry lower marks and are discouraged.
3. If extra components and batteries etc. are required, they can be supplied on payment of the discounted prices given above, subject to availability.

Judging Criteria:

- The judges will be given guidelines for judging as well as standardised questions etc. to minimise personal differences in judging.
- Each team and contestant will face a series of judges (say 3) each of whom will judge only a specific aspect of the contestant's knowledge, as well as how they measure the current, voltage, resistance etc.
- Where there is a tie in scores or difficulty in judging a winner, the project with smaller size, lower weight and/or lower cost will be given preference.
- A set of sample questions with hints and answers, along with guidelines for better presentation skills will be available on our website for the contestants to know what type of questions will be asked and what is expected of their presentations. The questions will be available and updated from about 1 month to 2 weeks before the contest. No updating will be done during the 2 weeks before the contest.

Note: If the participant team wants to build another project nothing fitting into the criteria of the above rules, the team can contact Javeed Ahmed Khan at peoscarchapter@gmail.com for further clarifications.