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# OFFICIAL RULES FOR THE 2024 TULSA ENGINEERING CHALLENGE

## ELECTRICAL MOTOR CONTEST

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### OBJECTIVE

Design, build and test an electrical motor powered by a single cell battery that rotates at the highest possible speed.

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### DESIGN STATEMENT

Each entrant will design, build and test an electrical motor. The motor shall be powered by one single cell battery. The motor is judged on its highest rotation speed with no load. The motor may be started by hand. The motor is to be constructed from basic materials and simple hardware readily available at retail stores or mail order suppliers. Components from commercially available motors or motor kits are not permitted. A design drawing and parts list indicating the source, cost and fabrication operations for each part must accompany the motor. The motor must be built by this year's entrant and not by a previous year's entrant.

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### CATEGORY SPECIFICATIONS AND COMPETITION LIMITATIONS

The motors submitted for judging will be divided onto Categories based upon their design and construction complexity. Simple motors (Categories B and C) are not permitted in the Upper Division (grades 9 thru 12) and the simple homopolar motor (Category C) is eligible only in the Lower Division (grades 6 and below) and will compete for separate prizes. The Categories and their definitions are:

- Category A – Traditional Electric Motor – A traditional rotating apparatus electric motor with potential for useful mechanical power output having clearly defined and identifiable field, armature and commutation (mechanical or electronic) components and not falling into the simple motor categories. Category A motors may compete in all Divisions.
- Category B – Simple Electric Motor (Beakman) – A simple rotating apparatus electric motor with a mechanically switched commutator which is usually a single segment of bare conductor on the coated magnet wire shaft also used to form the coreless rotating armature, commonly referred to as a “Beakman” motor. Category B motors may not compete in the Upper Division.
- Category C – Simple Homopolar Electric Motor – A simple rotating apparatus electric motor without a commutator using a permanent magnet field source coaxial with the rotation axis, commonly referred to as a “homopolar” motor. Category C motors may compete in the Lower Division only, and will compete in a separate class and prize structure from the other motors.

Note: The on-line encyclopedia [en.wikipedia.org](http://en.wikipedia.org) is a good reference for electric motor theory and terminology. Descriptions of the Beakman and homopolar simple motors can be found on YouTube.com and other on-line sources through Google searches.

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## **MATERIAL SPECIFICATIONS**

The motor must be fabricated from basic materials and not use parts from manufactured motors or kits. The power source must be a single cell battery with a volume not exceeding that of a conventional D size. The maximum nominal voltage shall not exceed four (4.0) Volts.

A design drawing clearly labeling each component and a corresponding parts list must accompany each motor. The parts list must indicate the source (vendor), cost, machining and fabrication procedure for each component.

There must be a 25 mm (1.0 inch) or larger diameter disc or 6.4 mm (0.25 inch) or larger diameter cylinder with a black surface supplied by the entrant and firmly attached to the motor shaft. The disc or cylinder surface must be easily accessible and readily viewed by an optical tachometer. A reflective tape marker will be attached by the judges. This mark will be viewed by an electro-optic tachometer to determine rotation speed.

The battery must be a single cell with a volume not larger than 53.2 cc (cm<sup>3</sup>) or 3.26 in<sup>3</sup>, or that of a conventional D size battery [33.2 mm (1.31 inches) in diameter by 61.5 mm (2.42 inches) long]. Nominal cell voltages of readily available batteries range from 1 to 4 Volts depending of the chemical technology used. The battery may not have more than one cell. Rechargeable batteries including lithium technology are permitted.

Industrial quality or other professionally manufactured motor components are not permitted. Manufactured kits or components from such kits will not be allowed. Pre-manufactured subassemblies such as armatures, field structures, or controller modules will not be permitted. Major components such as armatures, commutators, or field structures from motors or motor kits may not be used.

Readily available permanent magnets of simple shapes may be used. Electrical and electronic components such as switches, resistors (variable and fixed), capacitors, inductors, relays, transistors, integrated circuits and interconnection hardware readily available through local retail or mail order sources may be used. Materials such as wire, cable, string, wood, plastic, permanent magnets, metal sheet; bar and rod stock; common fasteners such as nails, screws, adhesives, staples and rivets; wheels, pulleys, bearings; and other common hardware items readily available in local retail stores may be used. Toy or hobbyist type articles such as erector set structural components may be used.

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## **CONSTRUCTION SPECIFICATIONS**

The motor must be constructed within the material constraints listed. Hobbyist, toy and readily available retail (local or mail order) hardware materials may be used. There must be a black disc or cylinder surface attached to the motor shaft to which a reflective tape marker may be attached by the judges and readily viewed by an optical tachometer to determine rotation speed. The judges will be the final authority for determining if unacceptable professional quality, special purpose or manufactured components or subassemblies violate the spirit of the competition. The design drawing, parts list and visual inspection of the motor will be a primary source for judging decisions.

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## COMPETITION SPECIFICATIONS

All power for operating the motor must come from the battery. Only single cell batteries with a volume not exceeding that of a D size cell are permitted with a nominal voltage not exceeding four (4.0) Volts. The battery is supplied by the entrant and may not be replaced during a timed contest. The battery may be replaced between the first and second trial. The motor may be operated by the entrant(s) through manual electrical controls such as switches, variable resistors or other electrical interface devices, or the system may operate automatically after starting. The entrant(s) may manually assist the starting of the motor.

The maximum stable no-load rotation speed of the motor will be determined by the judges using an electro-optic tachometer. An electro-optic tachometer observes and measures the rate that alternate light and dark reflective areas pass by a light sensitive detector. The black disc or cylinder surface for the reflective marker must be a part of the motor. The reflective tape and tachometer will be supplied by the judges.

The objective is to achieve the maximum possible rotation speed for the motor when operating with no load. Each entry will have two (2) one (1) minute timed runs. The higher observed speed score will be used. The entrant will have a one (1) minute setup and test period prior to the first run. No more than one (1) minute may elapse between the end of the first timed run and the beginning of the second timed run.

No intervention with the motor's operation is permitted during the timed run except through the electrical control panel or for starting. The motor may be started by hand or other auxiliary means. The motor must accelerate to a final stable speed if started by auxiliary means - it cannot "coast down" from a starting impulse. Repairs and adjustments are permitted between timed runs and during the setup period. Competition will run continuously during the Challenge competition hours. A table will be provided for the inspection and staging. The design drawing and parts list must be provided at inspection. The judges will determine the Category designation. The motor will be placed on the competition table and operated by the entrant. The judges will observe the rotation speed with the electro-optic tachometer during each of the one (1) minute timed runs and determine the maximum observed speed. The competition area will be off limits to everyone except the competitors and officials.

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## JUDGING AND SCORING

The score will be the maximum observed stable no-load rotation speed of the motor in revolutions per minute (rpm) reduced by any penalties. A penalty equal to 50% of the observed speed will be applied for any entry not providing a complete and accurate design drawing and parts list. Any motor using manufactured components from motors or motor kits will be disqualified. Each entrant is responsible for having the required black disk or cylinder for the reflective timing tape and providing batteries, supplies and tools as required. The judges will provide the tachometer and reflective tape. Prior to the testing, each motor will be inspected, assigned a Category and marked by the judges to indicate compliance with contest construction specifications. A motor shall be registered and operated by one and only one team. No re-registration is permitted. A team may register only one motor. After inspection by the judges, the motor will be assigned a Category and placed in the contest queue.

Each team is responsible for the security of its entry. No time will be spent looking for or waiting for teams not present when it is their turn. Teams not present will go to the end of the queue if

time permits. Decision of judges, during all phases of competition, will be final. Judges will determine winning entries at the close of the competition. Winners need not be present.

Any appeals are to be brought to the attention of the TECh Chair as soon as possible on the day of the competition. The TECh Chair and 2 advisors will collect relevant information from the student and the judges and will make a decision on how to proceed.

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## PRIZES

Prizes will be awarded for three divisions as follows: Upper Division (9<sup>th</sup> thru 12<sup>th</sup>), Middle Division (7<sup>th</sup> thru 8<sup>th</sup>), and Lower Division (6<sup>th</sup> grade and under). In the Lower Division prizes will be awarded for both the Category C and the all other Categories class. In the event of a tie, prizes will be equally distributed between winning entries.

### Division, Category and Prize Scheme:

- Upper Division (9<sup>th</sup>-12<sup>th</sup> grade) – Category A only – 1<sup>st</sup>, 2<sup>nd</sup> & 3<sup>rd</sup> Places
- Middle Division (7<sup>th</sup> & 8<sup>th</sup> grade) – Category A & B – 1<sup>st</sup>, 2<sup>nd</sup> & 3<sup>rd</sup> Places
- Lower Division (6<sup>th</sup> grade & under) – Category A & B – 1<sup>st</sup>, 2<sup>nd</sup> & 3<sup>rd</sup> Places
- Lower Division (6<sup>th</sup> grade & under) – Category C only – 1<sup>st</sup>, 2<sup>nd</sup> & 3<sup>rd</sup> Places

First Place:                    \$50 cash and \$25 cash for their classroom.

Second Place:                \$40 cash and \$25 cash for their classroom.

Third Place:                  \$25 cash and \$25 cash for their classroom.

Cash prizes will be awarded by a bank check and issued to the teacher/school listed on the registration to be cashed and distributed to the winning student(s). We will mail a check to the address listed on the registration within a few weeks of the competition. If you do not receive your prize or certificates within a few weeks, please email [info@tulsaengineer.org](mailto:info@tulsaengineer.org) with your team name, school, and competition won.

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## GENERAL

The contest is limited to four (4) entries per division per school. Each entry may be an individual or a team project of two to four students. It is recommended that the bigger participation schools stage run-off competitions on their home campus to select the “varsity teams” to compete at TECh if they have more than 4 potential entries.

**Registration will be done via the TECh web page which can be accessed through [www.tulsaengineer.org](http://www.tulsaengineer.org).**

Questions may be sent directly to the lead judge at [mkockok@gmail.com](mailto:mkockok@gmail.com). Please cc: [tulsatechchallenge@gmail.com](mailto:tulsatechchallenge@gmail.com)