Australian Acoustical Society
Queensland Division

# ACOUSTICS BURSARY

## *QUEENSLAND SCIENCE CONTEST 2021*

### The Bursary

The Australian Acoustical Society, Queensland Division will present an **$800** bursary for the best project in the field of acoustics; open to students in all Divisions. At the discretion of the judges, the bursary may be split among a number of entries (maximum of five).

### The Society

The Australian Acoustical Society is a learned society formed in 1971 to advance the science and practice of acoustics. Members practise or study acoustics in areas such as architectural acoustics, underwater acoustics, engineering noise and vibration, ultrasonics, environmental and occupational noise and vibration management, bioacoustics, hearing and speech physiology, audiology and music acoustics.

### Project Areas

Acoustics is the study of sound (and hearing) in air, water and other fluids and the interactions of sound with solid materials. It is a broad field and impinges on many aspects of the physical and biological sciences.

Project areas include:

- *Architectural acoustics*
- *Acoustical and vibration transducers*
- *Bioacoustics*
- *Engineering noise and vibration control*
- *Environmental noise and vibration*
- *Hearing and speech physiology*
- *Music acoustics*
- *Occupational noise and vibration*
- *Physical acoustics*
- *Seismology*
- *Ultrasonics*
- *Underwater acoustics*

In judging these awards, preference is given to submissions which demonstrate a good understanding of the physical and or biological principals involved and which present their material and results with clarity (this consideration is assessed relative to the year level and Division for which the project is entered).

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***ARCHITECTURAL ACOUSTICS:*** the study and design of rooms and other building spaces to determine those attributes which make them acoustically "fit for purpose". For example, to be "fit for purpose" an auditorium, lecture theatre or classroom must provide an environment which allows a person standing in front of the audience to be heard clearly. A bedroom must be quiet enough for sleep. A music venue must provide satisfactory acoustical conditions for musicians and audience while limiting the emission of "music noise" to the environment.

***ACOUSTICAL AND VIBRATION TRANSDUCERS:*** Transducers convert energy from one form to another. Mechanical, electromagnetic, optical and hydraulic components are used to receive or generate sound and vibration. "Pick-up" transducers include microphones, hydrophones, geophones and accelerometers. A loudspeaker is a familiar example of a transducer which converts an electrical signal into sound.

***BIOACOUSTICS:*** Animals use sound (and vibration) to explore their environment and to communicate. Bioacoustics involves the study of the uses and mechanisms of hearing and vocalisation in mammals, birds, reptiles, amphibians, fish, insects, crustaceans, molluscs and other animals. It includes the study of other effects of sound on biological systems. Acoustical techniques are used to identify and track individuals or groups of animals and to study their interactions with other species and their environment.

***ENGINEERING NOISE AND VIBRATION CONTROL:*** applies acoustical science to control unwanted sound (noise) and mechanical vibration. Mufflers employ a series of passages and chambers to attenuate engine noise. Building materials are used to encompass a noise source within a "box", more or less opaque to the sound produced within. Sound absorptive materials are used to damp reverberation and control resonance. Springs and dampers are used to isolate vibration from areas sensitive to its effects. "Active" noise and vibration control seeks to cancel noise and vibration by introducing a signal which is equal in amplitude and frequency but opposite in phase to one or more of the major components comprising the disturbance.

***ENVIRONMENTAL NOISE AND VIBRATION:*** Industry, mining, construction, road, rail and air transport, sporting and musical venues and home appliances such as air-conditioners, lawnmowers, vacuum cleaners and food blenders, produce noise. While such noise (and vibration) is often little noticed by those involved in the activity or using the appliance, it can cause intense annoyance to "the neighbours". There are many techniques available to abate this, from good land use planning, which separates residential areas from industry and transportation, to expensive "after-the-fact" treatments to reduce noise and vibration at source, at the receiver or in between.

***HEARING AND SPEECH PHYSIOLOGY:*** The physiology of hearing and speech has been investigated since ancient times. From the 1500's onwards increasingly detailed knowledge has been accrued as to the physical and physiological mechanisms involved. Today, with the many tools available to science and medicine, knowledge of hearing and speech, the diseases which affect them and the interventions which can help, continues to advance. Applications of this knowledge include improved therapies and the introduction of many devices to protect and assist hearing and speech. This includes the "cochlear implant" to provide a partial restoration of hearing in the profoundly deaf.

***MUSIC ACOUSTICS:*** is the study of the physical, physiological and psychological mechanisms behind music and musical instruments. Vibrating strings, membranes, plates and air columns are used in different ways in the various families of musical instruments. Similar mechanisms apply in the anatomy supporting the human voice. Systematic investigation of music acoustics began with Pythagoras and provides new insights today.

***OCCUPATIONAL NOISE AND VIBRATION:*** Exposure to loud noise can cause hearing loss. If the noise is loud enough and persists long enough, the person is rendered deaf. Thus in any occupation where high sound levels are involved, workers must be protected from its effects. Similarly, high levels of vibration over long periods can cause injury, for example to the hands when manipulating vibrating tools. Occupational noise and vibration is concerned with managing and minimising exposures so that the deleterious effects of loud noise and excessive vibration can be avoided.

***PHYSICAL ACOUSTICS:*** concerns the fundamental properties of sound. Phenomena such as sound transmission, absorption, reflection, refraction, diffraction, interference, scattering, dispersion and the mechanisms of sound propagation through gases, liquids and solids and through the fluid filled pores of rocks and other materials are relevant to the area. Physical acoustics includes the interaction of sound with light and other electromagnetic radiation (for example, sonoluminesence, photoacoustics and thermoacoustics) and the use of sound to investigate the properties of materials and to modify them (for example, sonochemistry). It also includes the mechanisms by which transducers convert acoustical signals to electronic or optical ones (and vice versa).

***SEISMOLOGY:*** uses vibrations transmitted through the earth to “sound-out” geological structures, elucidate the processes behind earthquakes and volcanoes and to prospect for water, oil and gas. In ancient warfare, groundborne noise provided a means by which the besieged could detect the tunnelling and undermining activities of their enemies. Today directional seismic arrays are used to locate artillery. Groundborne noise and vibration from underground railways, other transport and construction activities, is of current interest around the globe.

***ULTRASONICS:*** Sound at frequencies above 16 to 20 kHz is “ultrasonic” and unheard by people. Dogs and rabbits can hear sounds at up to 50 kHz, while cats and many rodents hear to around 90 kHz. As they echolocate to detect prey and avoid obstacles, bats and dolphins use higher frequencies again. Moths “vocalise” at around 80 kHz, but hear to well over 200 kHz. Ultrasonic imaging has many applications in medicine. It is also used to detect flaws in machinery, steel and concrete and in the lightweight composites used in racing vehicles, aircraft and wind-turbines. Intense ultrasound is used to clean and sterilise, induce chemical reactions and drill through materials too hard for other tools to process efficiently.

***UNDERWATER ACOUSTICS:*** Underwater, sound is everywhere. Most fishes, aquatic mammals, reptiles and invertebrates have a well developed sense of hearing and many communicate by vocalisation. Whales and dolphins “sing” and echolocate. Fish, “chorus” and shrimp, “snap”. Sonar was developed to detect and track submarines. Similar methods are used in fish-finding, depth-sounding and the investigation of submerged sediments. Underwater acoustic arrays are used to detect nuclear explosions and earthquakes and warn of tsunamis.