ABSTRACTS
SECTIONS III & IV

SECTION III – PHYSICS AND MATHEMATICS
Joint with
SECTION IV. ENGINEERING AND COMPUTER SCIENCE
Paper Session
Thursday Morning, 9:00 – 11:30 AM
KCC Room B
Mel Blake, Presiding

1. 9:00 AM **u MEASURING VISCOSITY WITH A DAMPED HARMONIC OSCILLATOR. *Donavan Ebersole*, Ty Naquin and James Sanders, Troy University. A mass-on-spring harmonic oscillator can be damped via Stokes' Law drag when placed in a viscous fluid. The viscosity of the fluid and hence the damping constant for the oscillator is temperature-dependent, so by changing the fluid temperature we can control the amount of drag present. We attached a spherical mass to a spring that was suspended in the liquid. After slightly displacing the mass, we record the Hooke's Law force during the motion. A graph of force versus time yields the damping coefficient and hence the coefficient of viscosity. This experiment yields the viscosity of glycerol at room temperature to within approximately 15% of the known value. The viscosity of glycerol at different temperatures remains to be shown; this is the current focus of our research.
2. 9:20 AM **u THE EFFECTS OF IMPACT VELOCITY ON IMPARTED IMPULSE. *H C Regan Bhatta*, Pawan Khanal, and James Sanders, Troy University. In this experiment, we have studied the relationship between the impulse imparted to an object its impact speed. The object is dropped onto a force-sensing platform, which records force as a function of time. An integration of this curve yields the imparted impulse. The time of contact with the platform is dependent both on the impact speed and the material properties. The relation between time of contact and impact velocity is, however, not linear.
3. 9:40 AM **u SOUND INTENSITY MEASUREMENTS TO METER SCALES. *Sebastian Lee*, Victoria Colvin and James Sanders, Troy University. The intensity of a sound wave falls off like the inverse square of the distance from the source provided that the medium through which it propagates is isotropic, lossless, and reflectionless. However, if the waves are reflected from nearby surfaces, then the returning sound waves can create interference maxima and minima. For a source-detector pair operated in a typical lab room, the data obeys the inverse square law to ~10-15 cm, but at greater distances interference becomes significant. In this experiment, the sound intensity level is measured as a function of distance from the speaker. The predicted intensity maximum and minima locations have been calculated via simulation, and our experimental results agree with these calculations to distances of up to 0.5 m. This represents a ~tenfold increase in the detector-source distance which was previously reported[1].

[1] A. Bates, “Decibels via Loudness—Distance Properties of a Loudspeaker.” The Physics Teacher, vol. 52, 302-303 (2014).

4. 10:00 AM **g ANALYTICAL SOLUTION OF THE NONLINEAR KLEIN GORDON EQUATION USING PERTURBATION METHOD. *Samuel Uba* and Matthew Edwards, Alabama A&M University. In this research, we propose the use of the perturbation method to solve the nonlinear Klein Gordon equation. The perturbation method is a useful mathematical tool for finding approximate analytic solutions to problems whose analytic solution cannot be found. The multi-scales method a type of the perturbation approximation is utilized to solve problems such as the nonlinear Klein Gordon equation whose analytical solution yields secular terms in the asymptotic expansion solution leading to a breakdown. We have analyzed the perturbation effect on the solution of the wave equation as it relates to condensed matter physics and compared the validity of our solution to other analytic methods
5. 10:20 AM **u MAPPING SOUND WAVES IN GNU OCTAVE. *Caroline Ho*well and James Sanders, Troy University. The intensity of a sound wave emitted from a point source in an isotropic and reflectionless region of space will decrease by the square of the distance from the source. However, if boundaries are introduced, then the reflected waves can interfere with each other and with the incident wave. Therefore, sound waves emitted from a source in an enclosed room will have an intensity which follows the inverse square law for short propagation distances, but deviates as incident and reflected waves of comparable amplitudes interfere with each other. This project makes use of the MATLAB clone GNU OCTAVE to calculate the intensity of a sound wave as a function of distance from a source which is placed in an enclosed room. This calculation considers multiple possible paths along which a wavelet can propagate along to reach the detector: a direct path, 6 paths containing one reflection each, and 30 paths containing two reflections each. It then determines the relative amplitude and phase for each of these paths in order to create a superposition of these 37 wavelets at the position of the detector. Squaring this superposition wave’s amplitude yields the sound intensity at the location of the detector.

10:40 AM **g CHARACTERIZATION OF ELECTRON TRAPPING AT DIELECTRIC/4H-SiC. *Isanka Udayani Jayawardhena* and Sarit Dhar, Auburn University. Silicon Carbide is a wide bandgap semiconductor that is desirable for metal oxide semiconductor field effect transistor (MOSFET) technology, especially in high voltage power electronics applications. However, a significant drawback in SiC MOSFETs is the high channel resistance due to trapping of carrier electrons in traps at or near the SiO_2/4H-SiC interface. Such traps are states within the bandgap with an exponentially increasing density near the conduction band-edge of 4H-SiC. For oxide films formed by thermal oxidation of 4H-SiC to SiO_2 without any special treatment, the interface state densities (D_{it}) are much higher ($> 10^{12}$ cm^{-2}) compared to traditional SiO_2/Si. Methods such as post-oxidation annealing, changing the dielectric to high-k materials and employing different 4H-SiC crystal orientation are few approaches that can lead to reduction of D_{it}. Constant capacitance deep level transient spectroscopy (CCDLTS) is a powerful tool that measures the thermal emission rates of trapped electrons to measure D_{it} and differentiate between different types of traps present based on measured emission activation energies and capture cross-sections. These measurements can be correlated to atomistic calculations of defect energy levels to identify physical identities of the traps/defects. In this talk, we will describe the details of the CCDLTS method and present results we obtained for SiO_2/4H-SiC MOS

capacitors fabricated in-house with different 4H-SiC crystal orientations and different dielectrics (SiO_2 and Al_2O_3).

11:20 AM BUSINESS MEETING: Elect a Section III. Vice-Chair for the 2019-2021 term

SECTION III – PHYSICS AND MATHEMATICS
Joint with
SECTION IV. ENGINEERING AND COMPUTER SCIENCE
Poster Session
Thursday Morning
KCC Atrium and Ballroom Foyer
Authors Set-up: Begins at 7:30 AM
Authors Present: 11:30 AM –1:00 PM
Mel Blake, Presiding

6. **u A NEW EQUATION TO PREDICT THE PHONON THERMAL CONDUCTIVITY OF PURE INTRINSIC SEMICONDUCTORS. *Clay Thompson*, Ayinde Chad, and Prakash Sharma, Tuskegee University. A Theoretical model is revisited under the frame work of Boltzmann Approximations. A new equation has been developed. The current model has been applied to predict the thermal conductivity of semiconductors. The phonon scatterings by the crystal boundary, the point defects and the phonons have been included. It has been shown that the model is successful in explain the temperature dependence of phonon conductivity of silicon.

7. **u LUMINESCENCE OF RARE EARTH DOPED GLASS. *Malcolm Johnson*, Prakash Sharma and Akshaya Kumar, Tuskegee University. Glasses are amorphous material and they are easy to prepare than growing crystals. When rare earth ions are doped in glass their optical properties are influence by the glass lattice structure. It is possible to tailor the optical properties of rare earth ions by changing the composition of glass. Rare earth ions doped glasses have wide range of optical applications such as they are used as laser materials and optical amplifiers. Using method of melting and quenching rare earth doped glass was prepared. The laser induced fluorescence measurement would be presented.

8. CUMULATIVE DISTRIBUTION AND CLUSTER ANALYSIS OF CONTINENTS AND ISLANDS. *Arjun Tan*, Alabama A&M University. Cumulative distribution and cluster analysis are two statistical tools used to analyze certain phenomenological studies. In this study, both are employed to analyze the statistical distributions of the sizes of the continents and islands using the square root of the area as the random parameter. The 6 continents and 51 largest islands were considered. The cumulative distribution places them on 3 distinct straight lines: one containing the continents and Greenland; the second containing the 5 largest islands after Greenland; and the third containing the smaller islands. A cumulative distribution in the logarithmic scale places them on 4 distinct straight lines: one grouping the continents; the second combining Australasia and Greenland; the third comprising the larger islands; and a fourth containing the smaller islands. Finally, a cluster analysis groups them in at least 5 distinct clusters of the continents, the large islands and at least 3 more clusters of smaller islands.

9. GROUPS, CLUSTERS AND CLUSTER ANALYSIS OF THE GREATEST BARBADIAN CRICKETERS. *Arjun Tan*, Alabama A&M University. In a span of 34 years were born 12 of the world's greatest cricketers in the tiny island of Barbados, 8 of whom were knighted and an equal number inducted into Cricket's Hall of Fame. They were born in 5 distinct groups within 2-year intervals who occupied different positions in the batting order. There were 3 opening batsmen, 5 middle-order batsmen including two all-rounders and a wicket-keeper batsman, and 4 fast bowlers, who were unanimously selected to the all-time Barbados cricket team. A cluster analysis was performed on the 12 cricketers which showed that they formed 6 distinct clusters of opening batsmen, middle-order batsmen including a wicket-keeper-batsman, all-rounders, and fast bowlers. Only one opening batsman had to be dropped to select the all-time Barbados cricket team. The captain and vice-captain were also selected.

10. MAGNETIC FLUX EMERGENCE, INTERCHANGE RECONNECTION, FLUX CANCELLATION, AND BLOW-OUT ERUPTIONS IN A SMALL CORONAL HOLE. M. L. Adams, NASA/Marshall Space Flight Center ; R.L. Moore, NASA/Marshall Space Flight Center and University of Alabama in Huntsville; and N.K. Panesar, NASA/Marshall Space Flight Center, Huntsville, AL. In this work, we report on the structure, evolution, and explosive behavior of an emerging-flux region of March 3-4, 2016. Flux emergence in a small coronal hole resulted in H-alpha brightening, subsequent eruptions, and the later development of a small sunspot. The initial emergence of a bipole, as seen in data from Solar Dynamics Observatory's (SDO) Helioseismic Magnetic Imager (HMI), was followed by the appearance of an anemone-type region, observed with SDO's Atmospheric Imaging Assembly (AIA) in multiple wavelengths (e.g., 193 Å, 211 Å, 304 Å, and 94 Å). We find that interchange reconnection of initially-closed emerging field with ambient open field affected the coronal hole, shifting the open field from one side of the emerging bipole to the other. A blow-out jet in this region is made by the eruption of a minifilament that forms over and erupts from a polarity inversion line between merging and cancelling opposite-polarity magnetic flux on the outside of the emerging bipole. There are three other blow-out eruptions from inside the emerging bipole; the largest of these makes a coronal mass ejection. Blow-out eruptions from inside emerging bipoles are rare. This emerging bipole had repeated blow-out eruptions from inside, probably because the emerging magnetic field was extremely twisted, which is evident from the sigmoid coronal form of the magnetic field. *Dr. Panesar's work was supported by the NASA Postdoctoral Program (NPP).*

11. **u MULTISPECTRAL ILLUMINATION SYSTEM BASED ON THE INDUCED WAVELENGTH SHIFT IN AN ARRAY OF FIBER BRAGG GRATINGS (FBG). *Jennifer Olszyna*, Dylan McKelvey, and Ravi Gollipalli, University of North Alabama. (SECTION IV. ENGINEERING AND COMPUTER SCIENCE) A multi/hyperspectral illumination system is based on the basic principle that there are many sources that can emit at different wavelengths over a very sharp wavelength band. However, it is not possible to obtain sources that can produce wavelengths in the ~10 nm FWHM range over a wide spectrum of UV to IR. In this study, we want to use the induced wavelength shift of FBG due to strain as the source of wavelength. By systematically arranging the FBGs to reflect wavelengths over a wide range, we aim to develop a multi/hyperspectral illumination system with very narrow bands of wavelengths as needed.

12. **u DEVELOPMENT OF A NOVEL SPATIAL ATOMIC LAYER DEPOSITION SYSTEM FOR FAST FILM DEPOSITION. *Tingyi Wei* and Dongqing Pan, University of North Alabama. (SECTION IV. ENGINEERING AND COMPUTER SCIENCE) Atomic Layer Deposition or (ALD), is a technique used for creating thin film layers for micro components that we use in everyday electronic devices such as smartphones, computers, and gaming systems. ALD uses surface chemical reactions, and chemicals such as trimethylaluminium [$Al_2(CH3)_6$ or TMA] with water (H_2O), to create single thin layers on a substrate in nanometer scale. This is accomplished by depositing the chemicals in a sequence to cause the chemicals to react one after another. It has been used in multiple applications to create transistors, processors, memory drives, as well as solar panels. ALD is a proven effective nano-manufacturing technique to deposit nano-scale thin films with remarkable uniformity and conformity in surface geometry. ALD is an effective technique with precise results, but it does have a critical flaw, namely low throughput, which relates to longer manufacturing time. For instance, a conventional single wafer ALD system can only achieve a few nanometers of layer thickness per minute of deposition. This is due to the sequence time when the reactive chemicals must be deposited and purged one at a time so as not to cause a volatile chemical reaction. This abstract is aimed at designing and developing a spatial ALD system, which adopts the spatial concept to deposit materials much faster than the traditional time-based ALD by eliminating the significant amount of waiting time.