**The University of New Mexico**

**School of Engineering**

**Electrical and Computer Engineering Department**

**ECE 535 Satellite Communications**

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Final Project: Peer Evaluation

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**Prof. Tarief Elshafiey**

**Modeling Lunar Gravitational Perturbations on Earth-Orbiting Satellites: Jacob Goldenstein**

Jacob gave a solid and well-structured presentation on his lunar gravitational perturbation simulation tool. He clearly explained the motivation behind the project, understanding how the Moon’s gravity gradually affects Earth-orbiting satellites, and tied it well to real-world applications like station keeping and satellite constellations.

One thing I appreciated was how he made the physics approachable. He walked us through how the simulation takes orbital elements as input and uses RK45 integration to model changes in inclination and eccentricity over a 29.5-day lunar cycle. The explanation of the perturbation terms and how they’re derived from the third-body acceleration model was also strong, especially considering how technical it could have gotten.

The graphs he showed made the effects clear, particularly the subtle but noticeable changes in eccentricity and inclination with lunar influence. I also liked that he didn’t shy away from discussing where the model didn’t match his expectations. For example, when the 3D plots didn’t reflect the expected orbital drift, he pointed it out honestly and framed it as a curious result rather than ignoring it. That kind of transparency really adds to the credibility of the work.

Overall, this was a great presentation. Jacob clearly put in a lot of work, and his tool has potential not just for educational purposes, but also for real satellite mission planning. His calm and honest delivery made it easy to follow, even with the more technical sections.

**Design, Construction, and Analysis of Low-Cost NOAA POES APT Ground Station: Daniel Thomson**

Daniel delivered an impressive and well-organized presentation on building a low-cost APT ground station to receive and decode imagery from NOAA satellites. From the start, it was clear how much effort and creativity went into the project, from selecting affordable components like the Raspberry Pi 5 and RSP1A SDR, to designing and tuning a custom V-dipole antenna using 3D-printed parts and copper rods.

He did a great job explaining the purpose of the NOAA satellites and how APT transmissions work. Even the more technical aspects, like modulation schemes and signal propagation challenges, were made accessible. The block diagram showing the full architecture, from antenna to IQ samples to final image decoding, really helped tie everything together.

What stood out most was Daniel’s clear grasp of both the hardware and software sides of the system. He explained how different parts interacted, from SDR Uno to WxToImg, and highlighted practical issues like FM interference, antenna pointing, and noise at low elevation angles. His discussion of the tuning process, including use of the nanoVNA to optimize the standing wave ratio, was especially well done.

The results he shared were fascinating. Seeing real satellite imagery, spectral density plots, and side-by-side comparisons of raw and processed images really emphasized the success of the project. Even when things didn’t go perfectly, like signal loss during a pass or poor reception due to terrain, it was presented with clarity and honesty, showing a thoughtful and thorough approach to troubleshooting and experimentation.

Overall, Daniel’s presentation was engaging, detailed, and very well executed. His enthusiasm for the project came through clearly, and it made for an enjoyable and informative experience.

**Parabolic Reflector Antenna Presentation: Andrew Lacaden**

Andrew gave a very detailed and engaging presentation on his project, a 3D-printable parabolic reflector antenna designed for DBS signal reception. He started with a clear explanation of the project’s goals and constraints, such as using common RF lab equipment like a WR-90 horn, copper tape, aluminum foil, and 3D-printed components. It was impressive to see how he worked within the 10-inch build limitation of his 3D printer by designing a reflector that could be assembled from four printed quadrants to form a 20-inch dish.

The technical depth of the presentation stood out. Andrew explained DBS signals, why he focused on the Ku-band, and how the higher frequency and smaller wavelength would allow for an electrically large antenna within a compact design. His breakdown of the horn characteristics, gain versus frequency data, and beamwidth considerations made it clear that he fully understood both the theoretical and practical aspects of antenna design.

The CST simulation results and F/D ratio analysis were well explained. Andrew demonstrated how parameter sweeps impacted resonance and gain, showing results that aligned with the theoretical gain of 34 dBi. His discussion of beamwidth and how it stayed well within the one-degree threshold required for geostationary satellite reception was thorough and easy to follow.

The link budget analysis using the Friis transmission equation was another highlight. He explained all variables and showed that the designed antenna could indeed detect DBS signals under optimal conditions. His comments about real-world factors like weather attenuation and the comparison with commercial offset reflectors gave additional context to his design approach.

Overall, Andrew delivered a well-structured, highly technical, and insightful presentation. His ability to connect design theory, simulation results, and practical implementation made the project both impressive and easy to understand.

**Two-Line Element Set Visualizer Presentation: Sahir Virani**

Sahir gave a clear and engaging presentation on his MATLAB-based Two-Line Element Set Visualizer. He started with a helpful overview of what TLEs are and what orbital parameters they contain, which made the technical content more accessible. The visual reference showing the orbital elements alongside the ISS TLE example helped ground the explanation and gave the audience a solid starting point.

The live demonstration of the MATLAB application was particularly well done. Sahir explained how users can load TLE files, whether it’s a single satellite or a full catalog like GNSS, and then select specific satellites from a dropdown menu. The interface was intuitive, with controls for simulation speed and real-time orbital visualization. It was also great to see how the tool provides real-time satellite position data, including UTC time, latitude, longitude, and altitude, all while showing both the satellite and its sub-satellite point on Earth.

What really stood out was how well the application balances simplicity with extensibility. Sahir made it clear that this was just the beginning and that the framework could support a wide range of future features, such as displaying multiple satellites or visualizing multiple orbital periods at once. This shows a strong understanding of both the technical foundations and the potential use cases.

Overall, Sahir’s presentation was well-structured, informative, and demonstrated a practical and effective tool for working with orbital data. It was a strong blend of technical depth and user-friendly design.

**GPS Speedometer Project: Conner Cook**

Connor delivered a clear and thoughtful presentation on his GPS-based speedometer project. Right from the start, he did a great job explaining the motivation behind the project, building a portable speedometer for his bike, and then walking through the necessary components to make that happen. His presentation had a logical flow, starting with GPS fundamentals like trilateration and NMEA sentences, then moving into hardware selection, software architecture, testing, and results.

The technical explanation was easy to follow, especially his breakdown of why he chose an Arduino Nano over other options like the ESP32. It was smart to point out the importance of having a 5V output to power both the GPS module and OLED screen. His hardware setup, including soldering and 3D-printing a custom case, showed attention to practical details, especially the consideration of GPS signal reception by placing the antenna on top.

The software portion was also well covered. Connor explained how he used libraries to parse the GPS output and display information on the OLED, and why he chose the u8g2 library over more commonly used alternatives due to performance and memory constraints. His approach to managing screen data and working within the limitations of the microcontroller showed a good understanding of embedded system constraints.

The testing and validation process was realistic and relatable. Since photographing the screen outdoors was difficult due to refresh issues, he found creative workarounds like testing in a car and comparing the GPS speed to a phone app. The photos he included made it easy to visualize how the system was mounted and how it performed in real conditions.

Overall, Connor’s presentation was engaging, informative, and demonstrated a strong grasp of both the technical and practical aspects of building a real-world GPS application. His approach to problem-solving and his clear communication made the project easy to understand and enjoyable to follow.