Introduction and Disclaimer

These mock examination questions span diverse disciplines and are designed for your practice in preparation for the International Research Olympiad (IRO) 2024. Endeavor to answer them to the best of your ability, utilizing this opportunity to enhance your skills and knowledge. For additional practice, it is advisable to engage in extensive reading of various papers; such efforts will contribute to a more comprehensive and nuanced understanding of the subject matter.

Try your best, and good luck! -International Research Olympiad 2024

Mock Examination Answer Key 2
Bolded answers are correct.

Paper 2: Energy Sustainability/Engineering

Question 1

Question: In the paper we can see that system applications can measure global solar irradiance. When examining most system applications regarding solar irradiance what is generally preferred as the main criteria?

a.) **Reasonable accuracy at a low cost is usually preferred in measuring global solar irradiance.**

- **The pyranometers that give accurate readings are quite expensive and hence not used extensively.**

b.) High accuracy at a high cost is usually preferred in measuring global solar irradiance.

- High cost isn't lucrative when it comes to this type of technology and its effectiveness.

c.) Low accuracy at a low cost is usually preferred in measuring global solar irradiance.

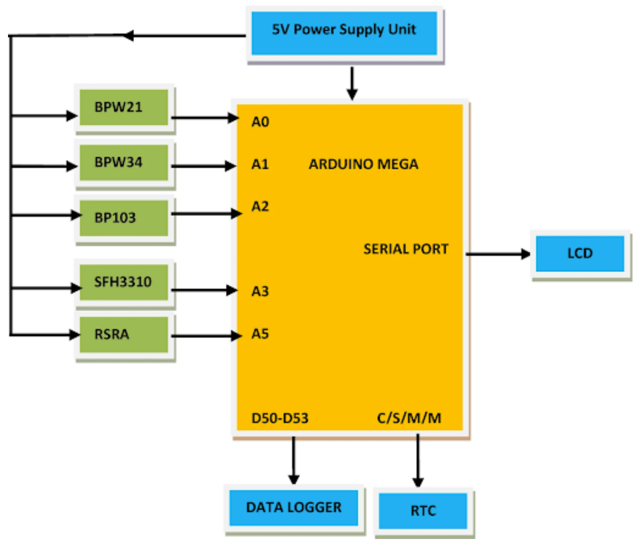
- While low cost is preferred the results still need to be accurate.

d.) Reasonable accuracy at a reasonable cost is preferred in measuring global solar irradiance.

- Reasonable accuracy needs to be a main criteria but what makes this answer wrong is that reasonable cost is not the MOST preferred path.

Question 2

Question: When looking at the block diagram for the comparison of the four solar radiation transducers (BPW21, BPW34, BP103, SFH3310) using a standard pyranometer (RSRA) as the benchmark what component makes this study novel?



a.) RSRA (Standard pyranometer)

- Used in most studies involving solar irradiance.

b.) Solar transition transducer BP103

- This transition transducer has been used previously and within the context of projects like this.

c.) Solar transition transducer BPW34

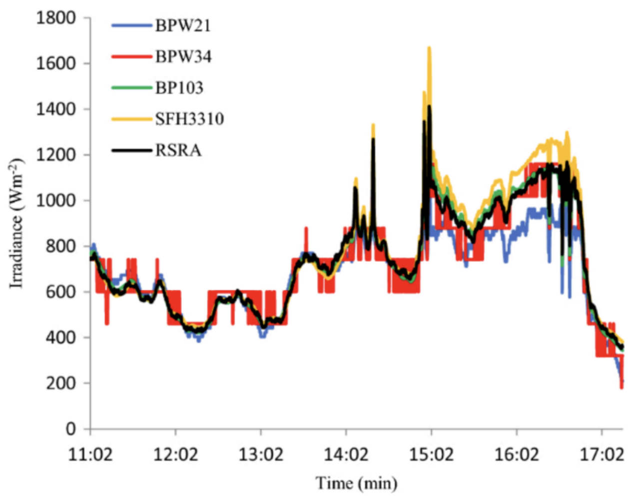
- This transition transducer has been used previously and within the context of projects like this.

d.) **Arduino Mega 2560**

- **Has an exceptionally high data logging rate of 6s which is comparable to those of the standard pyranometers of 1s.**

Question 3

Question: When looking at the figure, the four transducers have strong correlations with the standard pyranometer RSRA from 09:02 to 14:54, but there is a marked difference in irradiance measurements between 14:54 and 17:02. Photodiodes BPW21 and BPW34 exhibit MBE of -48.7466 Wm^{-2} and -15.2427 Wm^{-2}. This is indicative of what when pertaining to the study in specific?



a.) Computing error where the transducers were no longer able to store data within themselves and produced varying results.

- Possible, but such errors would likely lead to a complete data loss rather than a consistent overestimation.

b.) **Transducers over-estimated the measured data which was due to certain weather conditions.**

- **Correct. Weather conditions can affect the readings of solar transducers, leading to overestimation or underestimation of actual irradiance.**

c.) Solar radiation angle changed throughout the day and caused varying results for which the transducer was not able to account for.

- While solar angle does change and can affect measurements, the transducers are designed to account for this, making it an unlikely cause of the specific error observed.

d.) Change in setting of where the transducers were placed causing for varied results and outlier data points.

- This would not explain a consistent overestimation in the data; it would more likely cause random fluctuations or outliers in the measurements.

Question 4

Question: A strong correlation was observed between phototransistor BP103 and standard pyranometer RSRA on the dry day of 16 November 2021 with the lowest MBE of 3.0164 Wm^{-2} and the lowest RMSE of 22.0249 Wm^{-2}. When compared to phototransistor BPW34 and standard pyranometer RSRA on the dry day of 16 November 2021, the MBE was -15.2427 Wm^{-2} and the RMSE was 40.4330Wm^{-2}. What conclusions can be made from the evidence provided?

a.) **Phototransistor BP103 has an outstanding sensitivity at that period compared to BPW34 which qualifies it for pyranometer transducer.**

- **BP103's lower MBE and RMSE indicate higher accuracy and reliability, making it a suitable choice for a pyranometer transducer.**

b.) Phototransistor BP103 has poor sensitivity at that period compared to BPW34 which doesn't qualify it for pyranometer transducer.

- Incorrect, as BP103's performance metrics suggest superior sensitivity and accuracy over BPW34.

c.) Phototransistor BP103 has poor sensitivity at that period compared to BPW34 which does qualify it for pyranometer transducer.

- Misleading, since BP103's superior performance indicates better suitability for pyranometer transducer use.

d.) Phototransistor BP103 has an outstanding sensitivity at that period compared to BPW34 which doesn't qualify it for pyranometer transducer.

- Contradictory, as BP103's demonstrated sensitivity and accuracy support its qualification for pyranometer transducer use.

Question 5

Question: For this specific study, four certain types of optoelectronic transducers were used to have the best solar irradiance measurement. Looking at the table down below, what parameters made these four transducers optimal for this research study?

Parameters	BP103	SFH3310	BPW21	BPW34
Radiant sensitivity area (mm^2)	0.12	0.29	7.5	7.5
Operating temperature (°C)	−40 to+80	−40 to+100	−40 to+125	−40 to+100
Range of spectral bandwidth (nm)	420–1130	350–970	420–675	430–1100
Angle of half sensitivity (degree)	±55	±75	±50	±65
Dark current (nm)	≤100	<50	≤30	≤30

a.) They radiant sensitivity area of the photodiodes for BPW21, BPW34, BP103, and SFH3310 is extremely low, and they also have low operating temperature ranges.

- This answer is incorrect. The table does not provide information about low radiant sensitivity area or low operating temperature ranges for these transducers.

b.) The radiant sensitivity area of the photodiodes for BPW21 and BPW34 is much greater than those of the phototransistor BP103 and for phototransistor SFH3310, indicating that the photodiodes receive more solar energy than the phototransistors.

- This answer is incorrect. The table shows the opposite, with photodiodes having smaller radiant sensitivity areas compared to phototransistors.

c.) Phototransistor BP103 cannot withstand an operating temperature range of −40 to 80 °C, which is the smallest but least suitable for the weather in southwest Nigeria, the location of this study. The minimum angle of half sensitivity is ±40°, indicating that the performance of the transducers should be equal to almost 100°.

- This answer is incorrect. While it provides information about the operating temperature range and angle of half sensitivity, it does not address why these parameters make the transducers optimal.

d.) **The radiant sensitivity area of the photodiodes for BPW21 and BPW34 is much lower than those of the phototransistor BP103 and for phototransistor SFH3310, indicating that the photodiodes receive less solar energy than the phototransistors.**

- **Correct. This answer highlights the difference in radiant sensitivity area, suggesting that the photodiodes (BPW21 and BPW34) receive less solar energy compared to the phototransistors (BP103 and SFH3310), which makes the photodiodes optimal for this study as they are less sensitive to solar energy changes.**

Question 6

Question: A hurricane wreaks havoc and all our photodiodes/phototransistors are gone! A new photodiode/phototransistor needs to be chosen for solar irradiance measurement in northeast Nicaragua. The ideal temperature in northeast Nicaragua is 21°C−27°C. Based on the information in the paper, which of the following photodiode/phototransistor is optimal to use?

a.) Photodiode R - High sensitivity, High Cost, Operating Temperature $0 - 20°C$

- Does not meet the ideal temperature range, possibly compromising its effectiveness in local conditions.

b.) Photodiode A - Medium sensitivity, Medium Cost, Operating Temperature $0 - 10°C$

- Its operating temperature range is far below the required conditions, making it unsuitable for northeast Nicaragua.

c.) Photodiode I - Low sensitivity, Low Cost, Operating Temperature $0 - 19°C$

- Although cost-effective, it fails to cover the ideal temperature range, affecting its performance reliability.

d.) **Photodiode N - High sensitivity, Reasonable Cost, Operating Temperature** $0 - 26°C$

- **With its high sensitivity and suitable operating temperature range, it is the most fitting choice for accurate measurements in northeast Nicaragua.**