EE 344 Electronic Design Lab, 2021-22/II

List of Project Ideas (Ver Jan 5)

Project No. : JJ-1

Project Title	Solar-powered Street Light: Battery Management
Faculty Mentor	Prof Joseph John (jjohn@ee.iitb.ac.in, j.john@iitb.ac.in)
Application	Solar-powered Street Lights
Brief Description	Today solar-powered street lights are used all over India. Unfortunately, most of them malfunction after about a year. One of the major reasons is the poor battery management. This project will involve proper battery management (preventing both over-voltage and under voltage scenarios). Battery to be used: UPS battery 12V, 7AH (Example: Panasonic UP-PW1245P1). Assume charging from a 10W solar panel (VOC = 18 V, ISC = 0.6A). LED load = 5 W.
Work expected	Need to look in detail at the battery specifications and design a proper charging circuit keeping the over voltage protection in mind. Need to also design under-voltage protection circuit. Display the state-of-charge (SOC) and the remaining time available at full load (2.5W) and half load (1.25W). Your design should use analog circuits mostly, except for displaying SOC using Pt51 board.
Reference, if any	Battery data sheet. Reference material on battery charging and precautions to be followed. See JJ-1 sub folder in the following link https://drive.google.com/drive/folders/1vLQYrszWGdBRkJXafNnBKJWzq4XWAVLb?usp=sharing
Remarks/other comments	Open to both physical and online students. Max no. of groups allowed for online: 1

Project No. : JJ-2

Project Title	Solar-powered Street Light: LED intensity control (PWM or other electronic means)
Faculty Mentor	Prof Joseph John
Application	Solar-powered Street Lights
Brief Description	Today solar-powered street lights are used all over India. Unfortunately, most of them malfunction after about a year. One of the major reasons is the poor battery management and load control (to prevent battery discharge). Components available: Battery to be used: UPS battery 12V, 7AH (Example: Panasonic UP-PW1245P1). Assume charging from a 10W solar panel (VOC = 18 V, ISC = 0.6A). LED load = 5W. Note: Battery may get charged fully in summer; however, during rainy seasons or cloudy days, battery may not get fully charged.
Work expected	Your task is to design proper LED intensity control (electronic circuit) based on the state-of charge (SOC) of the battery for full load, half-load and one-fourth load. Display the state-of-charge (SOC) and the remaining time available at full load (2.5W), half load (1.25W) and one-fourth load (0.625 W). Your design should use analog circuits mostly, except for displaying SOC using Pt51 board.
Reference	Study general references on PWM schemes used for controlling load currents
Remarks, other comments	Open to both physical and online students. Max no. of groups allowed for online: 1

Project No. : JJ-3

Project Title	Distance measurement using Ultrasonic sensor (with digital display)
Faculty Mentor	Prof Joseph John
Application	Distance measurements up to 5 m
Brief Description	The goal of this project is to develop a distance measurement gadget, using Ultrasonic sensors (discrete Tx and Rx sensors). Note: Pt51 or other microprocessor kits not allowed for interfacing.
Work expected	Should develop signal conditioning circuits and all the required interface circuits using the Ultrasonic sensors. Should use a low-cost ADC cum digital display for displaying the distance. Range: 5m, Resolution: 1 cm
Reference	Refer to the specs of Ultrasonic Tx and Rx discrete modules (available in the WEL Lab) and understand the interfacing requirements. See JJ-3 sub folder in the following link for some general info https://drive.google.com/drive/folders/1vLQYrszWGdBRkJXafNnBKJWzq4XWAVLb?usp=sharing
Remarks, other comments	Open to both physical and online students. Max no. of groups allowed for online: 1

Project No. : JJ-4

Project Title	Diode Temperature sensor with Digital display
Faculty Mentor	Prof Joseph John
Application	Temperature measurements up to 100 deg C, with 0.5 deg resolution
Brief Description	The junction voltage of a Si diode decreases by 2 mV/deg C when the diode is driven through a constant current source. This technique can be used to measure temperatures fairly accurately.
Work expected	Requirement: design of a BJT based constant current source of 5 mA driving a Si diode. Use an appropriate signal conditioning circuit so as to get 10 mV/deg C. Display the temperature on a display Digital display: use a low-cost display that is compatible with the ADC. Note: Pt51 or other microprocessor kits not allowed for interfacing.
Reference	EE230 expt on current source using a pnp transistor. Look also at the data sheets of LM35 Temp sensor and also other diode temperature sensors to understand the design philosophy.
Remarks, other comments	Open to both physical and online students. Max no. of groups allowed for online: 1

Project No. : JJ-5

Project Title	Roof-top Water Tank Level monitoring (using Android App)
Faculty Mentor	Prof Joseph John
Application	Water level monitoring on an Android phone for deciding to switch-ON/OFF water filling pump motor.
Brief Description	One of the common problems faced is to decide when to switch-ON/OFF the pump motor. What is most commonly done is to have a fixed time when the pump motor is switched on. However, this is a severely flawed method as the water usage is highly dynamic. The aim of this project is to monitor the water level in a concrete tank, without putting any sensors inside the tank (as this is most often not possible due to a variety of reasons, esp when the water tank is that of a building consisting of say 20 to 50 flats). Hence, often manual operation of pump motor is what is done. This results in wastage of water as the pump operator has to handle the in a few buildings. Some non-invasive smart solutions are: a) Use a microphone/accelerometer to monitor the sound/vibrations when the tank is getting filled and alert the pump operator through an Andriod app when the water level is 90% or more. b) Use an ultrasonic sensor to monitor the water level in the vent pipe (fitted in every water tank to ensure atmospheric pressure inside the tank) and use an Android app to alert the operator. Here water level can always be monitored. c) Use a reed-switch or micro switch to detect over flow of water from the tank and alert the pump operator through an Android app.
Work expected	Your solution needs to be tested in one of the buildings in the campus, for example Satpura building where I reside (water over flow is a daily problem in the mornings and evenings). If the solution works reliably, the Esate office would be willing to install your design in other buildings.
Reference, if any	Find details from the internet about of the sensors mentioned here.
Remarks/other comments	Open only to students physically present in the campus. Three to four groups allowed. Solutions should include (a) and (c) or (b) and (c) indicated above.

Project No. : JJ-6

Project Title	VLC for Music Transmission
Faculty Mentor	Prof Joseph John
Application	White LED displays for both illumination and transmitting data – to transmit music/video through the VLC channel over 5 meters.
Brief Description	Today white LED displays are used everywhere for indoor illumination. The idea of using visible light for transmitting data is called Visible Light Communication (VLC) which is being explored extensively. Just like Wi-fi where wireless is used for communication, Li-fi is also a standard for communicating data within a room. Commercial products are also available. VLC is mostly used in the broadcast mode, but can also be used for bi-directional transmission.
Work expected	You need to build a white light LED transmitter giving sufficient illumination, say for an office room and also capable of transmitting data of about 100kbps to 2 Mbps. Receiver should also be capable of 2 MHz bandwidth. Testing should involve real time signals such as music or video. Use appropriate low-cost ADC and DAC for audio/video transmission.
Reference, if any	See JJ-6 sub folder in the following link https://drive.google.com/drive/folders/1vLQYrszWGdBRkJXafNnBKJWzq4XWAVLb?usp=sharing
Remarks/other comments	Open only to students physically present in the campus.

Project No. : JJ-7

Project Title	Low Cost 10 Mbps POF Link for Digital Transmission
Faculty Mentor	Prof Joseph John
Application	Low cost 10m POF data link (LED Tx – Si PIN Rx) for data transmission between two nodes.
Brief Description	Today glass optical fibers (GOF) are used everywhere for telecom and internet data, primarily because of their large bandwidths and extremely low losses. These fibers (what are called single-mode fibers) are cylindrical structures made of low loss glass, with core/cladding dimensions of 8/125 µm. They require specialized components and connectors. For short data links, say 10 to 50 m, Polymer Optical Fibers (POF) are used extensively today for networking applications, such as within a house or room, in place of a Wi-Fi. They are useful in applications that are short, say within 100m. The commonly used POF has a core dia of 1mm and is very easy to use. Internet operators such as Reliance Jio are now installing these POF fibers within buildings and flats. POFs also find extensive usage in other applications, such as automobiles – wherever link lengths are within say 50m and data rates are 100 Mbps to 1 Gbps.
Work expected	Design of LED based Tx which transmits Psuedo-random bit sequence (PRBS). PRBS of length 15bits can be easily generated using a 4-bit shift register. The LED preferably should be an ordinary RED display LED (available in the WEL Lab) with a proper 3-D printed connector (socket) for coupling LED light to the 1mm POF. At the receiving end, the light carried by the 10m POF is to be coupled to an Si PIN photodiode (using 3-D printed connector). The Rx circuit will have a trans-impedance amplifier (TIA) at the front end followed by a post amplifier (optional) and finally a high-speed comparator. Choose a proper Opamp for the TIA and also the post-amplifier (if required).
Reference, if any	See JJ-7 sub folder in the following link https://drive.google.com/drive/folders/1vLQYrszWGdBRkJXafNnBKJWzq4XWAVLb?usp=sharing
Remarks/other comments	Open only to students physically present in the campus.

Project No.: JJ-8

Project Title	20 MHz Receiver Frontend for POF Data Communications
Faculty Mentor	Prof Joseph John
Application	To be used as trans-impedance amplifier (TIA) in POF Rx applications
Brief Description	One of the most challenging sub system in a POF link is the Rx frontend. Up to about 5 to 10 MHz, high-speed Opamps can be used. Most of these Opamps are either low freq (such as TL-081) or very high freq opamps (with a GB product of 600 - 800 MHz). It is best to design a discrete TIA using JFETs and BJTs or entirely using BJTs. The requirements for a TIA for the POF Rx are both low noise and high bandwidth. These two are conflicting requirements. You may use high frequency discrete BJTs along with a JFET or JFET along with ICs with npn BJT arrays. A third option is to use MOSFET as the frontend device instead of the JFET, followed by BJT stages.
Work expected	Work would involve the following: i) Going through the reference material and understanding design considerations of TIA in a fiber optic receiver (to understand the sources of noise, choice of appropriate devices and components, and the bandwidth requirements). ii) A good design of TIA with the bare minimum devices – no more than three devices including the JFET/MOSFET. Looking at some commonly used designs and improving them, iii) Testing of your circuit using a Si PIN photodiode (optical signal transmitted using a LED Tx and the power coupled to the photodiode. We shall make the LED Tx available to you.
Reference	See JJ-8 sub folder in the following link https://drive.google.com/drive/folders/1vLQYrszWGdBRkJXafNnBKJWzq4XWAVLb?usp=sharing
Remarks, other comments	Open to both physical and online students. Max no. of groups allowed for online: 1

Project No.: JJ-9

Project Title	Contactless Thermometer
Faculty Mentor	Prof Joseph John
Application	For measuring the temperature of surface without contact (eg. Temperature measurement of humans, temp measurement of a hot liquid, etc), Range: 10 to 100 deg C, Resolution: 0.5 deg C
Brief Description	Contactless thermometers find extensive use in many fields. During the pandemic contactless thermometers are used almost everywhere to scan passengers/customers. However, these thermometers are designed for human temperature ranges, but with much better resolutions, typ 0.1 degF. Contactless thermometers are used extensively in industrial environments to measure the temperature of surfaces/points etc which are otherwise inaccessible. Also, it is commonly used to monitor the wheel as well as box (enclosing the wheel bearings) temperatures of rail coaches and wagons. For example, box temperatures should never exceed about 70 to 80 deg C. Similarly, wheel temperatures should be within 180 to 200 deg C. In case there is a brake failure or bearing damage, the above temperatures would rise substantially and will result in derailments.
Work expected	The project involves the design and integration of the following subsystems/components: optics, infrared sensor, signal conditioning, ADC cum display unit. Once the basic system is operational, it should be calibrated and tested using a standard temperature sensors, such as LM35.
Reference	Do a google search and understand the technique. You should also look at products to understand and appreciate the specifications.
Remarks, other comments	Open only to students physically present in the campus.

Project No.: JJ-10

Project Title	Electronic Load for Solar Panel Characterization
Faculty Mentor	Prof Joseph John
Application	Characterization of solar panels. Measuring voltages and currents of a solar panel for various loads, under different intensity levels.
Brief Description	In first year, you might remember doing Solar Panel characterization manually on the roof top of the WEL Lab. As you would appreciate, it is not at all convenient to do manual measurements all the time, esp when you want to characterize the Solar panel under different day light conditions. Electronic load is what is actually used in practice to characterize solar panels.
Work expected	The project work involves choosing the right power MOSFET, where the MOSFET itself acts as the load. You need to vary V_{GS} of the MOSFET under program control and obtain the terminal voltages and load currents.
Reference	Data sheets of power MOSFETs.
Remarks, other comments	Open only to students physically present in the campus.