# Measurement and Instrumentation Laboratory (EE3P005)

## EXPERIMENT-1

## Operation of Single-Phase AC Voltage Regulator

*Shorya Sharma*
*19EE01017*

## Aim:

To measure torque using transducer and measuring corresponding voltage developed

## Apparatus Required:

- Torque Transducer experimental module 1 No.
- Weighing Pan 1 No
- Weights up to 1 Kg 1 Set.
- Digital Multimeter 1 Nos.

## Theory:

When a uniform metallic cylinder of finite diameter D and length L, which has one end fixed and the other end free to twist, twisted, then the cylinder suffers torsion. The deformation of the cylinder is a measure of torque. Strain gauge/s bonded on the surface of this cylinder, instrategic positions provides scope for measurement of torsion suffered by the cylinder.

The experimental module has two mechanical parts, fastened. a) A torque transducer fixed on one side of the torsion bar and the other b) 1 meter long arm of uniform cross section, fixed to the movable flange. The 1-meter long uniform bar is connected to this free (movable)end of the Torque transducer while the other end is connected to a weighing pan. Weights can be suspended at the other end of this bar, such that the torque transducer is subjected toangular rotation, but prevented, as the other end of this cylinder is fixed. Now a relation between the strain measured with reference to the applications of different weights are studied. A built-in 3 1/2 digit display indicates the torque in terms of Kg/M. For example, a weight of 1Kg, placed at a distance of 1-meter (1000 mm) from the transducer is displayed as

1.000 on the digital meter.

When the same weight of 1-Kg placed at 500mm distance from the centre of the transduceris indicted as .500 on the digital display. Thus, for several weights in the range of 50gm to 1000gms in multiples of 50 gms can be added. These weights are placed at different distances from the transducer, and the Kg/M characteristics can be studied.

The trainer consists of torque transducer, Graduated 1meter long arm, instrumentation amplifiers, built-in power supply, and assorted weights. 3 1/2 digit display.

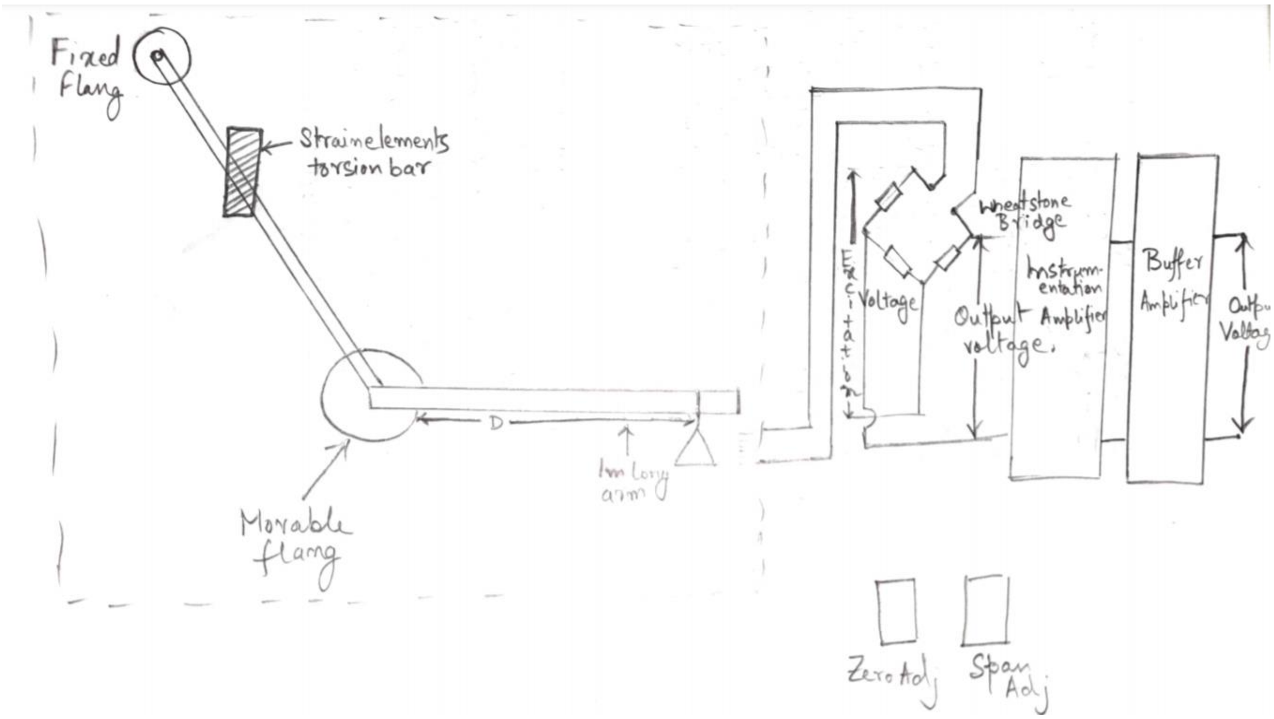
Torque is related to force being a turning moment on a shaft where a force (F) acts at a distance (R) from an axis. Torque measurement of rotating shafts is important in the determination of power and energy. When a power source transmits power to a sink along a shaft, as shown in Figure, the shaft suffers torsion. This is the application of opposing couples. The torque can be measured by cradling the sink or source and measuring the force of deflection. We use dynamometer technique. A torque sensor may also be placed along the rotating shaft and the signal telemetered to a static position. The type of arrangement for this latter technique is to use four strain gauge cells with each pair set at 45degrees to each other and each pair diametrically opposite each other on the shaft. This configuration is insensitive to axial or bending stresses.

## Procedure:

1. Connect a digital multimeter to the output terminals and switch on the instrument
2. Add 50 gm of weight to the weighing pan at 1M distance
3. Measure the output voltage using Multimeter and note down torque on DPM readingsand tabulate.
4. Calculate the torque using the formula and compare with the DPM reading
   Torque = Weight **x** Distance (KgM)
5. Increase the weight to 100 gms and measure the output voltage, and record.

6. Similarly increase the weight up to 1000 gms in steps of 50 gms and tabulate the readings as shown.

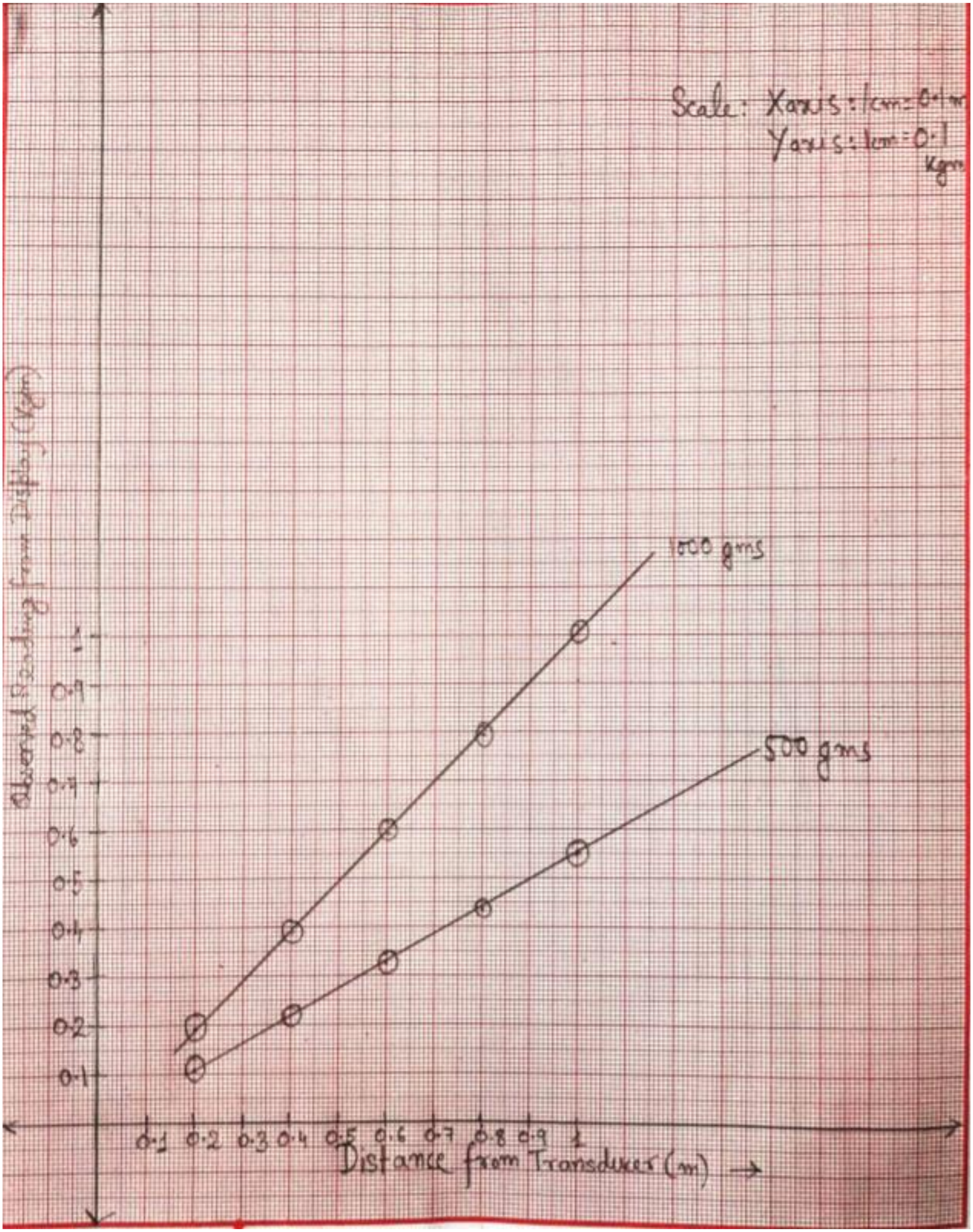
## **Circuit Diagram:**




## **OBSERVATION TABLE:**

| Weights in (Grams) | Distance in (Meters) | Output in (mV) on Multimeter | Reading of Torque on DPM | Calculated Torque using Formulae (Kgm) | Error % |
|---|---|---|---|---|---|
| 1000 | 1 | 99 | 1.001 | 1 | 0.1 |
| 1000 | 0.8 | 78.8 | 0.795 | 0.8 | -0.625 |
| 1000 | 0.6 | 59 | 0.596 | 0.6 | -0.667 |
| 1000 | 0.4 | 38.8 | 0.393 | 0.4 | -1.75 |
| 1000 | 0.2 | 18.9 | 0.191 | 0.2 | -4.5% |
| 500 | 1 | 54.5 | 0.550 | 0.5 | 10% |
| 500 | 0.8 | 43.4 | 0.438 | 0.4 | 9.5% |
| 500 | 0.6 | 32.3 | 0.326 | 0.3 | 8.67% |
| 500 | 0.4 | 21.2 | 0.215 | 0.2 | 7.5% |
| 500 | 0.2 | 10.1 | 0.103 | 0.1 | 3% |

**GRAPH:**



Scale: X axis: 1cm = 0.1 m
Y axis: 1cm = 0.1 Kgm
1000 gms
500 gms
Observed Reading from Display (Kgm)
Distance from Transducer (m)
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

# Conclusion

Thus, through the above-mentioned experiment, by using a torque transducer, we converted a physical quantity like torque to measurable electrical quantity like voltages on a small scale, that on a larger scale can be utilized for other purposes.

# Discussion

1. **What is the function of Wheatstone bridge?**

A Wheatstone bridge is used to measure small changes in resistance of a transducer. Whenever a force (weight) is applied, the dimensions of the torsion bar (strain elements) is changed which results in change in resistance. This torsion bar is connected to the Wheatstone bridge and whenever a change in resistance is observed the bridge becomes unstable and a potential difference arises which is the input to instrumentation amplifier.

2. **What is the function of Instrumentation amplifier?**

The output signal from a transducer is always a very small signal. In order to amplify the signal so that it can be used for display an instrumentation amplifier is used.

3. **What is the function of buffer amplifier?**

The function of buffer amplifier is to maintain the output voltage from the instrumentation amplifier. It provides electrical impedance transformation from one circuit to another.

4. **What is the dimension of transducer gain?**

Here, Transducer input is Torque and output is voltage. Transducer grain is output/input.

So, dimension of transducer gain: $ML^2T^{-3}I^{-1}/(ML^2T^{-2})$

$= T^{-1}I^{-1}$

4. **How much is the gain of overall measurement setup?**

Gain = Output voltage/input torque

= 100mV/1Kg-m = 0.1V/Kg-m

And it will be almost same for all input and output pair of values.