DESIGN AND CONSTRUCTION OF AN APPARATUS BASED ON MUTUAL INDUCTANCE TECHNIQUE FOR SUSCEPTIBILITY MEASUREMENTS

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ABSTRACT

Mutual inductance technique employed in Hartshorn bridge is one of the most convenient and reliable method for magnetic susceptibility measurements. In Hartshorn bridge, a two phase lock-in amplifier, a measuring coil, helipot, a mutual inductance box and *ac* power supply are connected in series, and a cathode ray oscilloscope is connected in parallel to the lock-in amplifier in order to measure the output signal. When a sample is inserted into the sample space of a secondary in the coil, it induces a voltage which can be detected by the lock-in amplifier as an off-balanced voltage as a measure of susceptibility of the sample.

In this study a two-phase lock-in amplifier and a measuring coil have been designed and constructed. The two-phase lock-in amplifier was constructed with six interconnected circuits: two input signals with in-phase and out-of phase, two demodulators and two low-pass filters. The demodulators and the low-pass filter circuits are used to multiply the input signals and to remove the *ac* component of the *dc* output respectively. The measuring coil was constructed with two secondaries of each 1,200 turns wounded in opposite direction over a coaxial primary coil of 3,000 turns on a cylindrical Teflon tube.

In an earlier study conducted in the Department of Physics, Eastern University, a low temperature *dc* electrical resistivity probe with four probe technique has been constructed for low temperature resistivity measurements. For the purpose of performing low temperature magnetic susceptibility measurements, the resistivity probe has been modified by exchanging the sample platform by a measuring coil that is connected in a Hartshorn bridge by four leads to the primary and secondaries of the measuring coil that would be at variable temperatures down to 77 K. In another study, a measuring coil was constructed with two secondaries of each 3,000 turns in opposite direction over a primary coil of 10,000 turns has been prepared for room temperature *ac* susceptibility measurements using the Hartshorn bridge. The measuring coil was used to validate the functionality of the constructed coil.

The induced magnetic field in the measuring coil with primary 3,000 (10,000) turns is verified to be linear up to ~4 mA (~10 mA) upon increasing and decreasing current. This study way forwarded to extend for temperature dependent susceptibility measurements using Hartshorn bridge upon installing the demodulator ICs (AD 630) in the constructed two-phase lock-in amplifier.

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