**ANSWER KEY SUBMISSION**

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| **Date of Exam & Session** | 13-10-2022 | **Category of Exam** | CLA2 |
| **Course Name** | SENSORS & TRANSDUCERS | **Course Code** | 18ECO133T |
| **Name of the Faculty submitting** | Dr.R. Surender | **Date of submission of Answer Key** | 17-10-2022 |
| **Department to which the faculty belongs to** | ECE | **Total Marks** | 50 |

**PART A (10x1= 10)**

**ANSWER ALL THE QUESTIONS**

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| **Q. No** | **Option** | **Answer** |
| 1 | a) | permeability |
| 2 | a) | 120 |
| 3 | b) | converted into electromotive force |
| 4 | b) | Vary unequally depending on the core position |
| 5 | c) | low |
| 6 | c) | Pitch and loudness |
| 7 | d) | Semiconductor based sensor |
| 8 | a) | 2 to 14µm |
| 9 | d) | Nickel-Chromium/Constantan |
| 10 | d) | All of the mentioned |

**PART B (4x4= 16)**

**ANSWER ANY FOUR OUT OF SIX QUESTIONS**

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| **Q.No** | **Question** |
| 11 | Write short notes on construction and working of synchros transducer.     * The Synchro is a type of transducer which transforms the angular position of the shaft into an electric signal. It is used as an error detector and as a rotary position sensor. * The voltage applied to the rotor induces the magnetizing current and an alternating flux along its axis. The voltage is induced in the stator winding because of the mutual induction between the rotor and stator flux. * The flux linked in the stator winding is equal to the cosine of the angle between the rotor and stator. The voltage is induced in the stator winding * The error occurs in the system because of the misalignment of the shaft. The transmitter and the control transformer are the two main parts of the synchro. |
| 12 | Explain the effect of thickness in working of capacitive transducers with necessary equation and diagram.     * The working principle of a capacitive transducer is variable capacitance. As per its structure, these are having two parallel metal pates which are maintaining the distance between them. * In between them, dielectric medium (such as air) can be filled. So, the distance between these two metal plates and positions of the plates can change the capacitance. * So, variable capacitance is the principle of these transducers. The basic difference between the normal capacitors and capacitive transducers is, the capacitor plates are constant in normal capacitors wherein these transducers, capacitor plates are the movable condition. |
| 13 | How capacitor microphone works. Explain?   * Condenser microphones use two charged metal plates (a diaphragm and backplate) that form a capacitor. * When soundwaves hit the mic's diaphragm, they vibrate within the diaphragm, and the distance between the back plate and diaphragm impacts the voltage called capacitance.   The movement of the diaphragm and the change in spacing produces the electrical signal that corresponds to the sound that's picked up. |
| 14 | With the help of neat sketch explain the working of pyroelectric thermal sensors     * Pyroelectric sensors are generally used to detect weak infrared irradiation due to their high sensitivities at room temperature. However, they require the use of metallic packages to insulate the sensitive element from thermal disturbances and electromagnetic noise, making their miniaturization difficult. * Moreover, it is difficult for the pyroelectric sensors to detect a stationary human body because the surface charge generated on the pyroelectric element disappears gradually when the human body is stationed. * Thermopile infrared sensors, which are used in remote thermometry, are also available, but they require the same thermal isolation technique and are unable to respond to fast signals. * As the sensitivity of thermopiles is one order of magnitude lower than pyroelectric infrared sensors, the application of thermopiles is thus limited to proximity sensing. |
| 15 | Write short note about scintillation detectors.   * A scintillation detector consists of a crystal or other phosphor coupled with its mount to a PM tube with a silicone oil light-couple. The oil light-couple is necessary to obtain an intimate connection of the phosphor with the photomultiplier to ensure the efficient passage of very small light photons. * The oil must have a refractive index similar to the glass of the tube. As of course it is light sensitive, the whole counter assembly is held in a light-tight metal counter-tube or support-tube, one end of which accommodates the multi-pin photomultiplier tube base. * Such a detector may be mounted upright, i.e., scintillator uppermost, for “end-on” or “well” counting of gamma samples. Strong beta emitters may also be counted in a well-type counter. Alternatively, the detector may be inverted for so-called “windowless” counting of beta emitters, in which the sample on a planchet is placed beneath the scintillator. Simple arrangements of this sort are shown in Fig. |
| 16 | Draw and explain the construction of thermocouple.     * A thermocouple is constructed of two dissimilar metal wires joined at one end. When one end of each wire is connected to a measuring instrument, the thermocouple becomes a sensitive and highly accurate measuring device. * Thermocouples may be constructed of several different combinations of materials. The performance of a thermocouple material is generally determined by using that material with platinum. * The most important factor to be considered when selecting a pair of materials is the “thermoelectric difference” between the two materials. A significant difference between the two materials will result in better thermocouple performance. |

**PART C (2x12= 24)**

**ANSWER THE FOLLOWING QUESTIONS**

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| **Q.No** | **Question** |
| 17 | 1. With necessary equations deduce the characteristic transfer matrix equation for electromagnetic transducers.       . |
|  | 1. What is meant by LVDT and explain its construction and working with the help of a diagram?   LVDT consists of one primary winding P and two secondary windings S1 & S2 mounted on a cylindrical former. Both the secondary windings (S1 & S2) has an equal number of turns and is placed identically on either side of the primary winding in such a way that the net output will be the difference of the voltage of both secondary windings. There is a movable soft iron core placed inside the former.   |  | | --- | | [LVDT Construction](https://1.bp.blogspot.com/-BrLP5Z_yVws/XlV6vJm4JRI/AAAAAAAAAfk/xeliU1hkNisEnGczCSVD-A-qwCR4mxYlQCLcBGAsYHQ/s1600/LVDT%2BConstruction.webp) | | **Construction of LVDT** |   Hydrogen annealing is done on the Iron core to reduce harmonics, residual voltage of the core and thus provides high sensitivity. The movable core also is laminated to reduce the eddy current losses. The displacement to be measured is attached to this movable soft iron core. LVDT is placed inside the stainless-steel housing because it will provide electrostatic and electromagnetic shielding. LVDT working principle The working principle of LVDT is based on the mutual induction principle. When AC excitation of 5-15 V at a frequency of 50-400Hz is applied to the primary winding, then a magnetic field is produced. This magnetic field induces a mutual current in secondary windings. Due to this, the induced voltages in secondary windings (S1 & S2) are E1 & E2 respectively.  Since both the secondary windings are connected in series opposition, So the net output voltage will be the difference of both induced voltages (E1 & E2) in secondary windings.  Hence Differential Output of LVDT will be  **E0 = E1 – E2**   |  | | --- | | LVDT Working | | Working of LVDT |   Now according to the position of the core, there are three cases that arise. So Let’s discuss these three cases one by one in detail.  **Case 1: When the core moves towards S1 (Max Left).**  When the core of LVDT moves toward Secondary winding **S1**. Then, in this case, the flux linkage with **S1** will be more as compared to **S2**. This means the emf induced in S1 will be more than the induced emf in **S2**. Hence **E1>E2** and Net differential output voltage **E0 = E1 – E2** will be positive. This means the output voltage **E0** will be in phase with the primary voltage.  LVDT operation  **Case 2: When the core is at Null position.**  LVDT operation  When the core is at the null position then the flux linkage with both the secondary windings will be the same. So the induced emf **(E1 & E2)** in both the windings will be the same. Hence the Net differential output voltage **E0 = E1 – E2** will be zero **(E0 = E1 – E2 = 0)**. It shows that no displacement of the core.  **Case 3: When the core moves towards S2 (Max Right).**  LVDT operation  When the core of LVDT moves toward Secondary winding **S2**. Then, in this case, the flux linkage with **S2** will be more as compared to **S1**. This means the emf induced in S2 will be more than the induced emf in S1. Hence **E2>E1** and Net differential output voltage **E0 = E1 – E2** will be negative. This means the output voltage **E0** will be in phase oppo |
| 18 | 1. Discuss in detail about the various types of thermocouples based on material used and temperature of operation.   Thermocouple Types Table |
|  | 1. Explain the construction and working of semiconductor-based sensors for measuring temperature. |