Skin Response Meter – Viva Questions

1. What is the Idea Behind the circuit?

Human skin offers resistance to current and voltage that change in sympathy with the emotional states of the body. The circuit is based on the changes in skin’s resistance followed by changes in the mental states. In the relaxed state, skin resistance is as high as 2 Meg ohms or more which reduces to 500k or less when the emotional state is too high. The reduction in skin resistance is related to increased blood flow and permeability followed by the physiological changes during high stress. This increases the electrical conductivity of the skin. So this circuit is useful to monitor skin response while doing relaxation techniques. The circuit is too sensitive and shows the response during a sudden moment of stress. Even a deep sigh will give response in the circuit.

2. What is meant by Galvanic Skin Response (GSR)?

Galvanic skin response (GSR), also known as electrodermal response (EDR), psychogalvanic reflex (PGR), or skin conductance response (SCR), is a method of measuring the electrical resistance of the skin. The GSR is highly sensitive to emotions in some people. Fear, anger, startle response, orienting response and sexual feelings are all among the emotions which may produce similar GSR responses.

A sample GSR signal of 60 seconds.

A transient change in certain electrical properties of the skin, associated with the sweat gland activity and elicited by any stimulus that evokes an arousal or orienting response. Originally termed the psychogalvanic reflex, this phenomenon became known as the galvanic skin response. Electrodermal response (EDR) has replaced galvanic skin response as the collective term.

The skin of a relaxed person has a low electrical conductance (high resistance), and the skin surface is some 40 mV negative with respect to interior tissues. Sweat gland activity changes these electrical properties by increasing skin conductance and by changing the balance of positive and negative ions in the secreted fluid.

Tonic skin conductance varies with psychological arousal, rising sharply when the subject awakens and rising further with activity, mental effort, or especially stress. Phasic skin conductance responses are wavelike increases in skin conductance that begin 1–2 s after stimulus onset and peak within about 5 s. The amplitude of the skin conductance response varies with the subjective impact of the eliciting stimulus, which in turn varies with the intensity of the stimulus, its novelty or unexpectedness for the subject, and its meaning or signal value. Aroused subjects display spontaneous skin conductance responses, generated apparently by mental events or other internal stimuli; their frequency, like the tonic skin conductance level, increases with the level of arousal.
Response of the skin to the passage of a small electric current. The ease with which the current flows between two points on the skin can be used to indicate stress. When a person is tense or emotional, the sweat glands become more active, increasing moisture on the skin; this allows the electric current to flow more readily. The response may also be used in relaxation training: information about the galvanic skin response is fed back aurally or visually to the subject who can, with practice, learn to increase or decrease sweating on the skin by learning to relax or tense muscles.

3. What is the relation between Emotion and Electrical conductivity of Skin?

Emotional state of human beings is a physiological mechanism to prepare the body to face situations. Stress and other emotional states are controlled by the hypothalamus, a region in the brain and the hormones secreted by the Adrenal gland situated on the kidney. Sympathetic and Para sympathetic nervous systems are also involved. Adrenaline is the chief hormone from adrenal gland responsible for creating stress. It is called as ‘emergency hormone’ because it prepares the body to face emergency situations. Some emotional feelings like fear, anxiety etc stimulate hypothalamus which in turn increases adrenaline secretion. The effects of adrenaline includes, increase in heart beat, B.P, increase in breath rate, sweating and in more severe case fainting. All these are to prepare the body alert to face the situation. One important effect of adrenaline is increased blood flow to the skin. This is to remove excess heat from the body through sweating. Human skin has the property of electrical conductivity and offers resistance to current. That is why burning occurs in shocks. The resistance and conductivity are inversely proportional. That is when the resistance decreases, conductivity increases. Normal skin (in calm mood) has high resistance and low conductivity. When the blood flow to the skin increases in stress, blood vessels becomes leaky and water leaks out to form the sweat. This mechanism removes heat from the body through the evaporation of sweat. When this happens, the resistance of the skin decreases to remove water easily. The moist skin also increases electrical conductivity. This aspect is used in the circuit. That is, skin’s resistance and conductivity are directly proportional to the emotional state.

**Calm mood**- Relaxed............ Less adrenaline.......low blood flow to skin........high skin resistance.......... Low conductivity.

**Stress** ............... High adrenaline .......increased blood flow to the skin ..........low skin resistance ..........increased conductivity.

4. What is Stress?

Stress is a biological term which refers to the consequences of the failure of a human or animal body to respond appropriately to emotional or physical threats to the organism, whether actual or imagined.

It includes a state of alarm and adrenaline production, short-term resistance as a coping mechanism, and exhaustion. It refers to the inability of a human or animal body to respond. Common stress symptoms include irritability, muscular tension, inability to concentrate and a variety of physical reactions, such as headaches and accelerated heart rate.

Stress in certain circumstances may be experienced positively. Eustress, for example, can be an adaptive response prompting the activation of internal resources to meet challenges and achieve goals.
It covers a huge range of phenomena from mild irritation to the kind of severe problems that might result in a real breakdown of health. In popular usage almost any event or situation between these extremes could be described as stressful.

5. What is Biofeedback?

Psycho-therapeutic and personal growth techniques are greatly enhanced by the use of a simple Biofeedback Monitor, a type of psycho-galvanometer. This serves to point out to the practitioner those emotionally "charged" topics which pass through the subject's mind, either consciously or pre-consciously. Without this device the practitioner is relying solely on body language; with the device, therapeutic procedures are so much more effective that it is now possible to use powerful techniques much more efficiently and successfully, and even to apply them upon oneself as the subject. The Monitor operates by the Galvanic Skin Response of the body.

The Tarchanoff Response is a change in DC potential across neurons of the autonomic nervous system connected to the sensory-motor strip of the cortex. This change was found to be related to the level of cortical arousal. The emotional charge on a word, heard by a subject, would have an immediate effect on the subject's level of arousal, and cause this physiological response. Because the hands have a particularly large representation of nerve endings on the sensory-motor strip of the cortex, hand-held electrodes are ideal. As arousal increases, the "fight or flight" stress response of the autonomic nervous system comes into action, and adrenaline causes increased sweating amongst many other phenomena, but the speed of sweating response is nowhere near as instantaneous or accurate as the Tarchanoff response.

The most advanced layers of the cortex, unique to Man, link to the thumb and forefinger especially, and there is a further complex physiological response which occurs when the forebrain is aroused. Changes in Alpha rhythms cause blood capillaries to enlarge, and this too affects resistance.

By virtue of the Galvanic Skin Response, autonomic nervous system activity causes a change in the skin's conductivity. The overall degree of arousal of the hemispheres, and indeed the whole brain, is shown by the readings of the GSR psychometer, which does not differentiate between the hemispheres, or between cortical and primitive brain responses. Higher arousal (such as occurs with increased involvement) will almost instantaneously (0.2 - 0.5 sec) cause a fall in skin resistance; reduced arousal (such as occurs with withdrawal) will cause a rise in skin resistance.

Thus a rise or fall relates directly to reactive arousal, due to re-stimulation of repressed mental conflict. Initially this may cause a rise in resistance as this emerging, previously repressed, material is fought against. When the conflict is resolved, by the viewing of objective reality - the truth of exact time, place, form and event - there is catharsis and the emotional charge dissipates; the release of energy giving a fall in resistance.

6. What is the role of Touch Pads?

Touch pads are used to make contact with the skin. It can be two small Aluminium sheets. When the touch pads are shorted with the middle and first fingers of the left hand (skin of left hand responds more to stress), current flows through it to the input of the signal amplifier. Touch pads can be of any type conducting plates such as Aluminium or copper plates having a dimension of 1x1cm.
7. What is the purpose of the Circuit?

The circuit is based on the skin’s electrical conductivity. The skin galvanic response depends on the resistance of the skin which varies depending on the stress level. In the fully relaxed state, skin offers around 2 Meg Ohm or more resistance which reduces to around 500 Kilo Ohms in the fully stressed condition. As a result of various physiological mechanisms during stress, blood flow to the skin increases and blood vessels becomes leakier. This increases sweating. As result, resistance of the skin reduces and it conducts more electricity. Thus the electrical conductivity is directly proportional to the stress level and skin resistance and electrical conductivity are inversely proportional.

8. What is the purpose of IC1?

IC1 (CA 3140) is designed as a sensitive amplifier to sense variation in the skin resistance. It is a resistance-to-voltage converter to produce varying output voltage based on the skin’s conductivity. IC1 is wired as an inverting amplifier to generate constant current to skin to measure the skin resistance. CA 3140 is the 4.5 MHz BiMOS operational amplifier with MOSFET inputs and bipolar output. The gate protected inputs have high impedance and can sense current as low as 10 pA. This device is ideal to sense small currents in low input current applications.

9. How IC1 works?

The inverting input (pin2) of IC1 is connected to ground through VR1 and to one of the touch plates while the non-inverting input (pin3) is grounded directly. Output from IC1 passes through the current limiter resistor R1 to the second touch plate. R1 acts as the feedback resistor along with the skin, when the touch plates make contact with the skin. So that the gain of IC1 depends on the feedback provided by R1 and the skin. In the inverting mode of IC1, a positive input voltage to pin2 through the feedback network makes its output low. If the skin offers very high resistance in the relaxed state, input voltage to pin2 reduces and output remains high. Thus the gain of IC1 varies depending on the current passing through the skin which in turn depends on the skin response and emotional state.

In the standby state, touch plates are free and there is no feedback to IC1 and it gives a high output (around 6 volts) as indicated by the shifting of the meter to right side. When the touch plates are shorted by the skin, the feedback circuit completes and the output voltage reduces to 4 volts or less depending on the resistance of the skin. Since the feedback network has a fixed resistor (R1) and VR1 is set to a fixed resistance value, the current flowing through it depends only on the resistance of the skin. The output from IC1 is displayed through a sensitive moving coil meter. VR2 adjust the sensitivity of the meter.

10. What is Resistance to Voltage Converter?

Resistance to Voltage converter is an Op Amp design meant for converting resistance to corresponding output voltage. As the current passes through a resistor to the inverting input of the Op Amp, its output voltage changes according to the current flowing into the input. That is high resistance give low current and output voltage will be low.
11. What is the peculiarity of IC CA3140?

CA 3140 is the 4.5 MHz BiMOS operational amplifier with MOSFET inputs and bipolar output. The gate protected inputs have high impedance and can sense current as low as 10 pA. This device is ideal to sense small currents in low input current applications.

12. What is the use of VR1?

VR1 reduce current to touch pads. The wiper of VR1 is kept at 7.5K for measurements of skin conductivity.

13. What is the function of R1?

R1 act as the feedback resistor along with the skin, when the touch plates make contact with the skin. So that the gain of IC1 depends on the feedback provided by R1 and the skin.

14. What is VU METER?

VU Meter is the short form of Volume Unit Meter. It is a very sensitive coil meter used to measure very small currents. It is commonly used to display the audio levels in Amplifiers and Tape recorders. The VU meter usually has 1K coil resistance and 0 to 10 digit readings.

15. How VU meter shows skin response?

The output of IC1 passes to the VU meter, then through the variable resistor VR2 to the ground. VU Meter is an Analogue coil meter and its needle deflection depends on the output voltage from IC1.

16. What is function of VR2?

VR2 adjusts the sensitivity of the VU Meter so as to keep the needle position at 0 when the output of IC1 is zero.

17. What is the function of VR3?

VR3 is the variable resistor used to control the input voltage to IC2. When the input of IC2 gets 125 milli volts, its first LED light up. So VR2 can be adjusted to light the first LED when the circuit is in standby.

18. What is Display Driver?

LM 3915 is the Integrated circuit to drive 10 LEDs or a Seven Segment Display to indicate the voltage levels. When the input of the IC 3915 gets 125 millivolts, its first output (pin18) sinks current and the LED connected to the pin lights. With each increment of 125 milli volts, the remaining outputs sink.
Current and the corresponding LED lights. This gives an analogous LED display. The display can be Dot Mode or Bar Mode depending on the connection of Pin 9.

19. **How IC 3915 works?**

LM 3915 Scale Logarithmically and span 0dB to 30 dB in ten 3 dB steps. It is used in signal strength measurements.

These ICs have 10 outputs each capable of sinking current to light LEDs brightly. Up to 4 LEDs can be connected to each output serially if the supply voltage is more than 9 volts. LED does not require a series resistor since the IC can regulate output current according to the value of the *Programme resistor* in the pins 6 and 7.

IC 3915 is a Monolithic integrated circuit that senses analogue voltage levels at pin 5 and sinks the outputs from 18 to 10 in a logarithmic fashion. For each increment of 125 milli volts, the outputs from 18 to 10 sinks current. That is normally the outputs are high. In the circuits only 5 outputs are used.

Input voltage to pin 5 required to turn on last LED (pin10) is equal to the reference voltage applied to pin 6 (high end). The input voltage required to turn on first LED (pin1) depends on the voltage applied to pin4 (low end). But the limitations are pin4 cannot be taken below 0 volt and pin6 1.5 volts below the supply voltage. Basic sensitivity of the IC is set by connecting pin 6 and 7. So that the input voltage required to turn on last LED (pin 10) is 125 milli volts. The low end (pin4) of the resistor chain is connected to the negative terminal of the reference (pin8) pin through 0 rail. So that the input voltage required to turn on first LED (pin1) is 125 milli volts. In this state, each increment of 125 milli volts turns another LED on.

20. **What is the Pin assignment of LM 3915?**

- Pin 3 - Positive (3-15 V)
- Pin 2 - Ground
- Pin 4 - Low end of the *internal resistor chain*.
- Pin 5 - Signal input. Each LED from pin 18 to pin10 lights at the increment of 125 milli volts in the input.
- Pin 6 - High end of the internal resistor chain.
- Pin 7 - Voltage reference output. 125 milli volt if pin8 is connected to 0 rail.
- Pin 9 - Mode selector. Dot mode display if not connected. Bar mode display if connected to positive rail.
- Pin 1 - First LED lights at power on. Represents 0 dB.
- Pin 18 to 10 LED connectors.
21. **What is the function of VR4?**

VR4 adjust the brightness of LEDs.

23. **How the circuit measures skin response?**

After assembling the circuit, adjust the presets properly. No LEDs turn on at this position with the touch plates open. Then make a gentle contact on the touch plates with the lower side of the middle finger. Keeps the finger reasonably still allowing 1 minute bonding with the pads and keeping the body relaxed. Adjust VR3 till Green LED lights and meter shows full deflection. At this position of VR3, input voltage to pin 5 of IC2 will be around 300 Milli volts. Adjust VR2 to get maximum deflection of the meter. This indicates the normal resistance of the skin provided that the body is fully relaxed. If there is an ill feeling or stress, skin resistance decreases and yellow and then red LED lights along with a deflection of meter towards the lower side. In short, Red LED and Zero meter reading indicate a stressful condition and Green LED and high meter reading indicates relaxed state. Practice some relaxation techniques and observe how much your body is relaxed.

24. **What is the Scope of the circuit?**

Electrodermal responses are measured in studies of emotion and stress, conditioning, habituation, and cognitive processing, that is, when it is desired to assess the differential or changing impact of a series of stimuli. It is a useful add on device in Lie detection, Polygraphy, Biofeedback monitoring etc.