2025 SHS2 END OF SEMESTER EXAM APPLIED ELECTRICITY 2 SOLUTION
ESSAY
PAPER 2

1. (a) Values of resistors X, Y, and Z:

X (Red, Red, Brown, Silver): 220 Ω ±10%
Y (Yellow, Violet, Brown, Gold): 470 Ω ±5%
Z (Green, Blue, Brown): 560 Ω ±20%

(b) Differences between Carbon and Wire-wound resistors:

1. **Construction:** Carbon resistors are made from a mixture of carbon powder and a binder, while wire-wound resistors are made by winding a resistive wire (like nichrome) around a ceramic core.
2. **Power Rating:** Wire-wound resistors can handle much higher power and dissipate more heat than carbon resistors.
3. **Tolerance:** Wire-wound resistors are generally more precise and have lower tolerance values than carbon composition resistors.
4. **Cost:** Carbon resistors are typically cheaper to manufacture.
5. **High-Frequency Performance:** Carbon resistors perform better at high frequencies, whereas wire-wound resistors have high inductance which limits their high-frequency use.

2. (a) Definitions:

i) Ideal Transformer: An ideal transformer is a theoretical transformer that operates with no energy losses, resulting in 100% efficiency. In such a transformer, there is no magnetic flux leakage, meaning all the flux generated by the primary coil links completely with the secondary coil, and its windings have zero resistance.

ii) Auto Transformer: An auto transformer is a type of transformer that uses only one winding, which serves as both the primary and secondary winding. A portion of this single winding is common to both circuits, and it can be used to step-up or step-down voltage by making connections at different tap points along the winding.

(c) Transformer Calculations:

Primary Voltage (Vp) = 230V
Secondary Voltage (Vs) = 12V
Primary Turns (Np) = 800
Power supplied (Power out) = 12W

i) To find the number of secondary turns (Ns):

Use the transformer voltage/turns ratio formula:

$$\frac{Vp}{Vs} = \frac{Np}{Ns}$$

Rearrange the formula to solve for Ns:

$$Ns = \frac{Vs}{Vp} \times Np$$

Substitute the given values:

$$Ns = \frac{12V}{230v} \times 800$$

$$Ns = 41.74$$

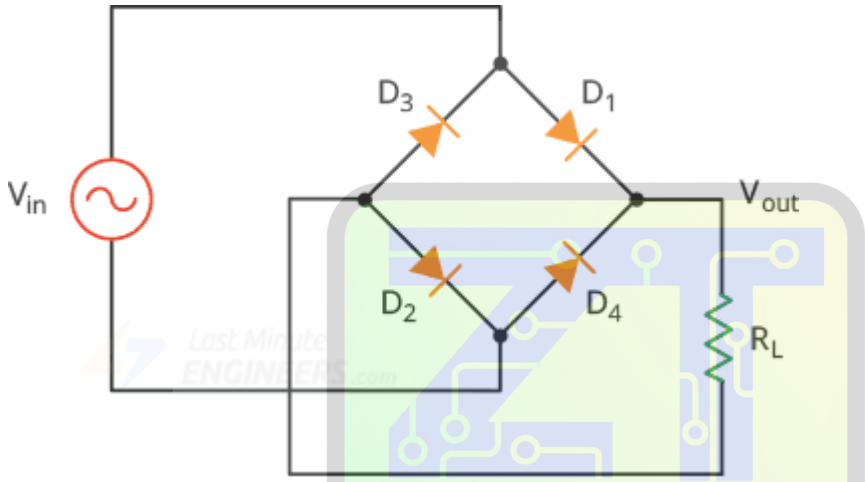
Therefore, the number of secondary turns is approximately 42 turns.

ii) To find the primary (Ip) and secondary (Is) currents:

calculate the secondary current (Is) using the power formula P=V∗I:
Is=Power/Vs
Is=12W/12V
Is=1A
For an ideal transformer, Power In = Power Out. So, Primary Power (Pp) = 12W.

calculate the primary current (Ip) using the power formula:
Ip=Power/Vp
Ip=12W/230V
Ip=0.052A

3. (a) Full Wave Bridge Rectifier Circuit:



3. (b) (i) Positive Half Cycle:

1. The top of the AC source is positive, and the bottom is negative.
2. This forward biases two diagonally opposite diodes (e.g., D1 and D2).
3. Current flows from the source, through the first forward-biased diode, through the load resistor, through the second forward-biased diode, and back to the source.
4. The other two diodes are reverse-biased and do not conduct.

(ii) Negative Half Cycle:

1. The polarity of the AC source reverses; the bottom is positive, and the top is negative.
2. This forward biases the other pair of diagonally opposite diodes (e.g., D3 and D4).
3. Current flows from the source, through the third forward-biased diode, through the load resistor *in the same direction as before*, through the fourth forward-biased diode, and back to the source.
4. The first pair of diodes is now reverse-biased.

4. (a) Methods of generating electrical power:

1. Hydroelectric (using water flow from dams)
2. Thermal (burning fossil fuels like coal, oil, or natural gas)
3. Nuclear (using nuclear fission)
4. Solar (using photovoltaic cells to convert sunlight)
5. Wind (using wind turbines)
6. Geothermal (using heat from the earth)
7. Biomass (burning organic matter)

4. (b) Electric Heater Calculations:

Energy (E) = 2.7 MJ = 2,700,000 Joules
Voltage (V) = 230V
Time (t) = 30 mins = 1800 seconds

(i) To find the Power rating (P) of the heater:

Use the formula: Power = Energy / Time
P=2,700,000J/1800s
P=1500W or 1.5kW

(ii) To find the Supply current (I):

Use the formula: Power = Voltage * Current
Rearrange to solve for Current: I = P / V
I=1500W/230V
I=6.52A

PART II

5. (a) (i) 11001_2 to decimal: 25_{10}

$=(1\times2^4)+(1\times2^3)+(0\times2^2)+(0\times2^1)+(1\times2^0)$
$=16+8+0+0+1$
$=25$

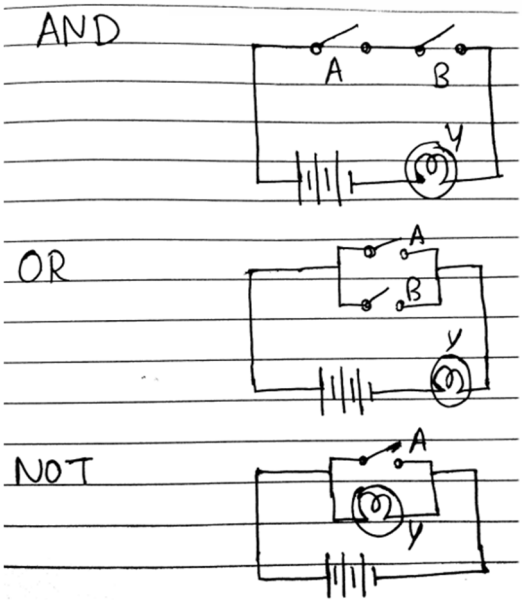
(ii) 25_{10} to binary: 11001_2

Division	Quotient	Remainder
25 ÷ 2	12	1
12 ÷ 2	6	0
6 ÷ 2	3	0
3 ÷ 2	1	1
1 ÷ 2	0	1

Now, write the remainders **from bottom to top → 11001**

(b) OR/AND/NOT Logic Gate:

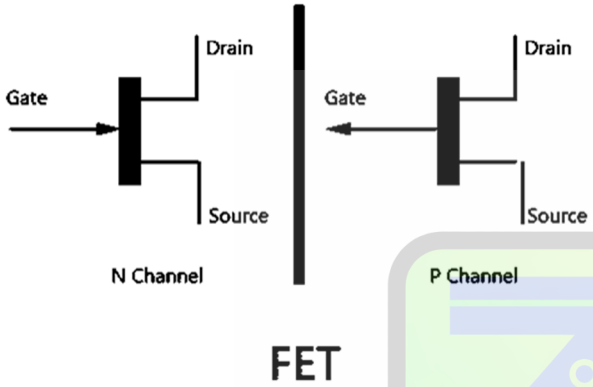
(i) Switching Arrangement:



(ii) Truth Table for two-input OR gate:

Input A	Input B	Output Q
0	0	0
0	1	1
1	0	1
1	1	1

6. (a) FET Symbols:



FET

6. (b) (i) Applications of FETs:

1. As amplifiers in audio equipment and radio receivers.
2. As electronic switches in digital circuits.
3. In buffer amplifiers due to high input impedance.
4. In voltage-controlled oscillator (VCO) circuits.

(ii) Advantages of FETs over BJTs:

1. **High Input Impedance:** FETs draw very little current from the input source.
2. **Less Noisy:** They generate less electronic noise than Bipolar Junction Transistors (BJTs).
3. **Better Thermal Stability:** They are less prone to thermal runaway.
4. **Simpler to Fabricate:** They can be made smaller on integrated circuits.

7. (a) Explanation of Terms:

i. Primary cells: Primary cells are electrochemical cells in which the chemical reaction is not reversible. Once the chemical reactants are consumed and the cell is discharged, it cannot be recharged. These cells are designed for single use and are discarded afterward, which is why they are also known as disposable batteries.

ii. Secondary cells: Secondary cells are electrochemical cells that utilize a reversible chemical reaction. This allows them to be recharged by passing an electric current in the opposite direction of the discharge. Because they can be used multiple times, they are also known as rechargeable batteries.

(b) Differences between Primary and Secondary cells:

1. **Reversibility:** The chemical reaction in primary cells is irreversible, while it is reversible in secondary cells.
2. **Rechargeability:** Primary cells cannot be recharged, but secondary cells can.
3. **Internal Resistance:** Primary cells generally have a higher internal resistance than secondary cells.
4. **Cost:** Primary cells have a low initial cost, but secondary cells have a lower total cost of ownership over their lifespan.
5. **Energy Density:** Primary cells often have a higher initial energy density.

(c) Applications of Secondary cells:

1. **Automotive batteries:** For starting cars, lighting, and ignition.
2. **Consumer electronics:** In laptops, mobile phones, and digital cameras.
3. **Power backup systems:** In uninterruptible power supplies (UPS).
4. **Electric vehicles:** To power the motors.
5. **Grid energy storage:** To store excess energy generated from renewable sources.