EOOW LEVEL (III/I)
UK COC

SYLLABUS

QUE. NO.	NAME OF THE TOPIC	PATTERN
1	Heat Transfer Through Solids, Liquids, And Gases.	Theroy+ Numericals
2	Thermal Expansion Of Solid	Theroy+ Numericals
3	Steam	Theroy+ Numericals
4	Gas Laws, Non-Flow Processes, Steady Flow Energy Equation	Theory+ Numericals
5	Combustion	Theory+ Numericals
6	I.C. Engine Performance	Theory+ Numericals
7	Refrigeration	Theory Only
8	Hydrostatics	Theory+ Numericals
9	Archimedes Principle	Theory+ Numericals
10	D.C. Circuit	Theory+ Numericals
11	Power Calculations - Heater/Furnace, Temperature Dependency Of Resistance	Theory+ Numericals
12	A.C.Circuit	Theory+ Numericals

OMTC

Q-1:
HEAT TRANSFER THROUGH SOLIDS, LIQUIDS, AND GASES.

EOOW/SCIENCE B/ QUESTION BANK /HEAT TRANSFER

1. (a) Heat is added to raise the temperature of 2 m^3 of air from 0°C to 35°C
   Calculate how much heat is required at EACH of the following:
   i. Constant pressure; (3)
   ii. Constant volume. (3)
   (Assume density of air= 1Kg/m^3; C_p=1.0 KJ/Kg.K and C_v= 0.72 KJ/Kg.K)

   (b) 400 kJ of heat is removed from a block of aluminium with a mass of 25 kg at 40°C. Calculate the final temperature. (4)
   (For Aluminium C= 0.92 KJ/Kg.K)

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2. A steel crankshaft of mass 250 Kg at a temperature of 475°C is placed into an oil bath 4 m long by 1 m wide filled to a depth of 1.5 m with oil of density 870 Kg/m^3 at a temperature of 25°C. Calculate the final temperature of the oil and crankshaft.
   Note: C for oil 1.85 KJ/Kg.K
   C for steel 0.49 KJ/Kg.K (10)

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3. Determine the heat transfer in one hour by conduction through a rectangle of iron of constant cross-sectional area when one face of the iron is maintained at 400°C and the other is at 180°C. The iron is 0.5 m square and 25 mm thick.
   (k for iron = 48W/m.K) (10)

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4. (a) State, giving a reason, for EACH of the following, the effect on heat transfer through a material by increasing:
   i. The area (2)
   ii. The thickness (2)

   (b) It is required to insulate a sheet of copper 1.6 m by 800 mm. The outer surface of the copper is to be maintained at a temperature of 135°C. The ambient temperature is 18°C, and the heat loss through the mineral wool insulating blanket is 5.4 MJ per hour.
   Calculate the thickness of a mineral wool insulating blanket in mm.
   (K for the mineral wool blanket is 0.04 W/m.K) (6)

5. (a) Calculate the time taken for a 3-kW heater to raise the temperature of 10 kg of water from 15°C to 83°C (6)
   (c = 4.2 KJ/Kg.K)

   (b) Explain why in practice, the actual time taken will be longer than the time calculated in Q1 (a) (4)

6. (a) Explain the principle of heat transfer by convection. (5)
   (b) Distinguish between the term Insulator and Conductor giving one practical Example of EACH. (5)

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7. (a) State the THREE modes of heat transfer, giving a practical example of EACH mode. (3)

   (b) Distinguish between the *'Kelvin'* and *'Celsius'* temperature scales. (5)

   (c) Define the term *Temperature.* (2)

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8. (a) Distinguish between the terms *heat* and *temperature*, giving examples to demonstrate your answers. (4)

   (b) Define *Absolute Temperature* and explain how this relates to the Celsius temperature scale. (6)

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9. Explain the following terms, giving examples in each case:

   (a) Conduction (3)

   (b) Convection (3)

   (c) Radiation (4)

Q-2:
THERMAL EXPANSION OF SOLID

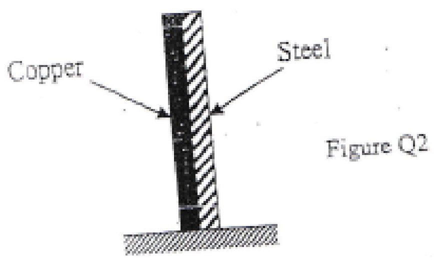
SCIENCE-B/EOOW/THERMAL EXPANSION OF SOLID

1. With respect to metals:
   a. Describe the term coefficient of linear expansion and give examples of where knowledge of the coefficients is used in engineering. (10)

2. With reference to metals:
   Describe the term coefficient of linear expansion and give THREE examples of where knowledge of coefficients is used in engineering (10)

3. A brass ring has a mean diameter of 270 mm when the temperature is 17°C. Calculate the temperature to which the ring should be heated in order to increase the diameter by 2 mm. Take the coefficient of linear expansion of the brass to be 1.9×10^{-5}/°C. (10)

4. Figure Q 2. shows a bimetal strip made of copper and steel. With reference to a coefficient of linear expansion and explain what happens as the bimetal strip is cooled. (10)



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5. A Stainless-steel exhaust valve has a stem diameter of 20 mm at 20°C. The clearance within the cast iron valve guide, at the same temperature, is 0.5 mm. The mean temperature of the valve stem is 150°C when the engine is running, and that of the valve guide is 70°C. Calculate the change in clearance between the valve guide and the valve stem when the engine is running. (10)

   Take the coefficient of linear expansion of stainless steel to be 14.4 x 10^{-6}/°C
   Take the coefficient of linear expansion of cast iron to be 10.8 x 10^{-6}/°C

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6. A brass bearing bush, outside diameter 250 mm at 20°C, is to be inserted into the top end of a steel con-rod which has a bore of 249 mm at 20°C. Calculate the temperature of the bush required to allow installation when the con-rod is at a temperature of 35°C. (10)

   Take the coefficient of linear expansion of brass to be 18.7 x 10^{-6}/°C
   Take the coefficient of linear expansion of steel to be 10 x 10^{-6}/°C

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7. A stainless-steel turbine blade, length 100 mm, is attached to the steel turbine wheel of diameter 800 mm, measured at 30°C. When the turbine is running, the mean blade temperature is 310°C, and the mean wheel temperature is 150°C. If the casing temperature remains constant, calculate the change in clearance between the blade tip and casing when the turbine is running. (10)

Take the coefficient of linear expansion of stainless steel to be 14.4 x 10^{-6}/°C
Take the coefficient of linear expansion of steel to be 10 x 10^{-6}/°C

8. With reference to the coefficient of expansion, explain the reason that when a Boiler is laid up full of water, arrangements for expansion and contraction should be made. (10)

9. A block of cast iron measures 24 mm x 15 mm x 10 mm at 0°C. Calculate the final volume of the block when its temperature is raised to 100°C. Take the coefficient of linear expansion iron to be 0.00001/°C (10)

10. With reference to the coefficient of linear expansion, explain the reason that an exhaust valve, operated by a rocker's arm, requires a clearance between the valve stem and the rocker tappet. (10)

11. Ethyl alcohol has a coefficient of cubic expansion of 0.0011/°C. Calculate the final volume when the temperature of 0.05 litres of ethyl alcohol is reduced from 40°C to -15°C. (10)

Q-3:
STEAM

EOOW/SCIENCE-B/QUESTION BANK/STEAM

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1. (a) Define the terms enthalpy of fusion, enthalpy of evaporation, and specific heat. (6)
2. (b) Give an example of the enthalpy of fusion and enthalpy of evaporation. (4)

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3. Feed water enters a boiler drum at a temperature of 36°C and a pressure of 50 bar. It leaves the boiler drum as steam with a dryness fraction of 0.98. The steam then passes through a superheater, where its temperature is raised to 400°C. The pressure is constant throughout. Calculate:
   a) The specific volume of the steam leaving the:
      i) Boiler drum; (2)
      ii) Superheater (2)
   b) The increase in specific enthalpy of the steam in the:
      i) Boiler drum; (3)
      ii) Superheater (3)

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4. Water, initially below its boiling temperature, is heated at constant atmospheric pressure. At the end of the process, the water has become superheated steam.

a) Sketch a graph of temperature variation against heat supplied. (4)

b) Explain the main features of the graph. (6)

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5. A cylinder contains 0.3 m^3 of steam at 1.01325 bar. The mass of the steam is 0.4kg. Calculate:

(a) the specific volume; (2)

(b) the dryness fraction; (2)

(c) the specific enthalpy; (3)

(d) the change in total enthalpy if the steam is heated at constant pressure until it is dry and saturated. (3)

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6. A steam condenser contains 5 m^3 of wet steam at a pressure of 0.05 bar. The total mass of steam present is 0.195 kg. Calculate:

(a) the temperature in the condenser; (1)

(b) the specific volume of the steam; (2)

(c) the dryness fraction of the steam; (2)

(d) the mass of the liquid present; (3)

(e) the total internal energy of the wet steam. (2)

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7. A steam condenser contains 3.85 m^3 of wet steam at a temperature of 52.6°C. The total mass of steam present is 0.418 kg. Calculate:

(a) the pressure in the condenser; (1)

(b) the specific volume of the steam; (2)

(c) the dryness fraction of the steam; (2)

(d) the mass of the liquid present; (2)

(e) the total internal energy of the wet steam. (3)

8. Feed water enters an evaporator at a temperature of 30°C and a pressure of 40 bar. It leaves the evaporator as steam with a dryness fraction of 0.95. The steam then passes through a superheater where its temperature is raised to 500°C. The pressure is constant throughout.

Calculate:

(a) The specific volume of the steam

  (i) Leaving the evaporator; (2)

  (ii) Leaving the Superheater (2)

(b) The increase in specific enthalpy of the steam in the:

  (i) In the evaporator (3)

  (ii) In the Superheater (3)

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9. Superheated steam in a cylinder is cooled at constant pressure. At the end of the process, the steam has become an undercooled liquid.

(a) Sketch a graph of temperature against volume for the process. (4)

(b) Describe the condition of the fluid at each stage of the process. (6)

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10. Sketch a pressure-volume diagram for steam, clearly labelling EACH of the following features:

(a) The saturated liquid line ("f" line); (1)

(b) The dry saturated vapor line ("g" line); (2)

(c) The liquid, wet vapor, and superheated vapor regions; (3)

(d) A constant temperature line that passes through all three regions (4)

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11. A cylinder contains $0.2m^3$ of steam at 7.0 bar. The mass of the steam is 0.8kg. Calculate:

(a) the specific volume; (2)

(b) the dryness fraction; (2)

(c) the specific internal energy; (3)

(d) the change in total internal energy if the steam is heated at a constant pressure until it is dry and saturated. (3)

Q-4:
GAS LAWS, NON-FLOW PROCESSES, STEADY FLOW ENERGY EQUATION

SCIENCE-B/QUESTION BANK/GAS LAWS AND PROCESSES

1. 0.41 kg of an ideal gas enters a non-flow system at a temperature of 12°C. During compression, 95 kJ/Kg of work is done on the gas, and 23 kJ/Kg of heat is lost. Determine the temperature of the gas at the end of the Compression.

   C_v for the gas is 695 J/Kg.K (10)

2. Calculate the mass of air in a receiver that has a capacity of 5 m^3 and Contains air at a pressure and temperature of 30 bar and 34°C, respectively.

   R for air is 0.287KJ/kg.K (10)

3. 0.25m^3 of an ideal gas at 14 bar and 200°C is expanded to a cylinder with a volume of 0.745m^3 and a pressure of 3 bar.

   Calculate the change in temperature of the gas (10)

4. A starting air bottle has a capacity of 0.35m^3. The pressure and temperature in the bottle just before use are 270 bar and 24°C. The air in the bottle is then used to start an engine without replenishment. Ten minutes after starting, the bottle pressure is 180 bar, and the temperature has returned to 24°C. Calculate the mass of air used to start the engine. (10)

   R for air is 0.*287KJ/kg.K*

5. A perfect gas has an initial pressure, temperature, and volume of 1.2 bar, 16°C, and 2.45m^3, respectively. The gas is now compressed to a volume of 0.15m^3 and 52°C. Calculate the final pressure of the gas. (10)

6. The state of the steam entering a turbine, operating under steady-flow conditions, is pressure 40 bar, specific volume 0.08 m^3/kg, specific internal energy 3010 kJ/kg, and velocity 20 m/s. The state of the steam leaving the turbine is pressure 0.04 bar, specific volume 34.8 m^3/kg, specific internal energy 2415 kJ/kg, and velocity 120 m/s. The mass flow rate of steam is 3.6 tonnes/h, and 200 kJ/kg of heat is rejected to the surroundings. Calculate the power and state its direction. (10)

Note. S.F.E.E. is $\frac{C1^2}{2} + gZ_1 + u_1 + p_1v_1 + q = \frac{C2^2}{2} + gZ_2 + u_2 + p_2v_2 + w$

7. 0.2 kg of air under initial conditions of pressure 1 bar and temperature 20°C is compressed to a final pressure and temperature of 1MPa and 112°C, respectively. R for air is 0.287 kJ/Kg.K

Calculate:

(a) The initial volume of air; (5)

(b) The volume at the end of compression. (5)

8. In a steady flow system, the fluid enters the system with a velocity of 200 m/s at a pressure of 10 bar with a specific volume and specific internal energy of 0.15 m^3/kg and 525 kJ/kg, respectively. At the exit from the system, the fluid has a velocity of 20 m/s at a pressure of 1.0 bar with a specific volume and specific internal energy of 1.048 m^3/kg and 250 kJ/kg, respectively. Calculate the heat transfer if the work done in the system is 290 kJ/Kg (10)

Note. S.F.E.E. is $\frac{C1^2}{2} + gZ_1 + u_1 + p_1v_1 + q = \frac{C2^2}{2} + gZ_2 + u_2 + p_2v_2 + w$

Q-5: COMBUSTION

EOOW/SCIENCE-B/QUESTION BANK/COMBUSTION

1. a. Describe the process of combustion. (3)

   b. Describe the conditions necessary to commence the combustion process and how these might be affected by the type of fuel. (4)

   c. Describe what is meant by the term hydrocarbon, giving examples to illustrate your answer. (3)

2. With reference to the combustion of a fuel:

   a. Describe EACH of the following:

      i) complete combustion; (2)

      ii) Incomplete combustion (2)

   b. Define EACH of the following:

      i) Stoichiometric air; (2)

      ii) air/fuel ratio; (2)

      iii) rich mixture. (2)

3. With reference to the combustion of fuel for production work:

   a. State the most common elements involved during the combustion process (3)

   b. Explain how the elements stated in Q3(a) combine with oxygen when burnt; (3)

   c. State the additional compounds that may be present in marine fuel oils, explaining the significance these have on the combustion process and machinery. (4)

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4. The mass analysis of a fuel that undergoes complete combustion using 35% excess air supply is 83% carbon, 14% hydrogen, and 3% sulphur. Determine the quantity of air required to burn 150 kg of the fuel. (10)

Note: Air contains 23% oxygen by mass.
Relative atomic masses: carbon 12, oxygen 16, hydrogen 1, sulphur 32.

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5. The process of combustion is important to marine engineers.
   a. Describe the process of "combustion." (3)
   b. Describe the conditions necessary to commence the combustion process and how these might be affected by the type of fuel. (4)
   c. Describe what is meant by the term "hydrocarbon"' by giving examples to illustrate your answer. (3)

6.
   a. Define the term Products of Combustion. (2)
   b. Give TWO examples of products of combustion produced from the combustion of Diesel fuel oil. (1)
   c. Define the term Fuel. (2)
   d. Briefly explain how energy is released when a fuel is burnt. (5)

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7. With reference to the combustion of a fuel, explain EACH of the following:
   a. The meaning of the ideal amount of air required for the combustion and how this may be calculated; (5)
   b. Why excess air is always provided. (5)

8.

a. Define the term calorific value as applied to fuels and give examples of the units used. (4)

b. Describe the higher calorific value and lower calorific value with respect to its usage when characterizing a fuel. (6)

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9. A quantity of Propane (C_3H_8) is to be combusted in pure oxygen.

a. Sate the stoichiometrically balanced equation for the combustion process, explaining how it is produced (8)

b. Explain how the chemical energy stored in the fuel is released for conversion to work. (2)

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10. With reference to the combustion of a fuel, explain EACH of the following:

a. How the higher calorific value of a fuel is determined; (6)

b. The effect the quantity of water vapor produced has on the higher calorific value and the lower calorific value, stating the reasons. (4)

Q-6:
I.C. ENGINE PERFORMANCE

EOOW/SCIENCE B/QUESTION BANK/I.C. ENGINE PERFORMANCE

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1. The area of an indicator diagram, taken from a four-cylinder four-stroke diesel engine, is 378 mm^2, the length is 70 mm, and the spring scale is 2 bar/mm. The engine cylinder diameter is 250 mm with a 350 mm stroke. When the card was taken, the engine was running at 300 rpm. Calculate:
   a. The mean effective pressure in the cylinder; (4)
   b. The indicated power of the engine, assuming all the cylinders are identically powered. (6)

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2. A 4-cylinder, 4-stroke engine has a bore of 250 mm, stroke of 315 mm, and runs at 600 rpm. The indicated mean effective pressure is 7.8 bar, and the brake-specific fuel consumption is 0.09 kg/kWh. The engine uses 5.2gm/s of fuel.
   a. The engine indicated power; (4)
   b. The engine brake power; (4)
   c. The mechanical power loss. (2)

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3. A 4-cylinder, 4-stroke engine has a bore of 300 mm, a stroke of 380 mm, and runs at 720 rpm. The mean effective pressure is 9 bar, and it has a mechanical efficiency of 87%.
   a. The cylinder indicated power in kW; (7)
   b. The engine brake power in kW. (3)

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4. The area of an indicator diagram, taken from a four-cylinder four-stroke diesel engine is 385 mm^2, the length is 70 mm, and the spring constant is 1 mm = 1 bar. The engine cylinder diameter is 250 mm with a 300 mm stroke. When the card was taken, the engine was running at 300 rpm, assuming all the cylinders were identically powered. Calculate:
   a. The mean effective pressure in the cylinder; (4)
   b. The indicated power of the engine (6)

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5. The total quantity of heat supplied to a diesel engine from the combustion process is 272.25 kW. The indicated power is 176.5 kW. The quantity of heat lost to the exhaust is twice the quantity of heat lost to the cooling water. Calculate
   a. The quantity of heat lost to the exhaust; (7)
   b. The mass flow rate of cooling water per hour required to maintain the temperature change of the jacket cooling water at 35°C. (3)
   Take c for jacket cooling water as 4.18 kJ/kg K

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6. An oil engine develops an indicated power of 52 kW. The brake-specific fuel consumption is 0.37 kg/kWh. The engine has mechanical losses due to friction of 12%. Calculate:
   a. The brake power; (4)
   b. The fuel consumption per hour. (6)

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7. The following results were obtained during an engine trial on a single-acting, single-cylinder, two-stroke engine:

Bore	150 mm
Stroke	200 mm
Engine Speed	220 rpm
Indicator diagram mean height	11.5 mm
Engine indicator spring rate	50kN/m^2 per mm

Calculate:

a. The mean indicated pressure in the cylinder; (3)

b. The indicated power of the engine. (7)

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8. An engine consumes 16.2 kg of oil per hour of calorific value 42.5 MJ/kg when developing 128 kW brake power. The mechanical losses are 20%

Calculate:

a. The brake thermal efficiency of the engine; (3)

b. The brake-specific fuel consumption (5)

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9. An engine consumes 14.6 kg of fuel oil per hour when developing 30.3 kW brake power. The mechanical losses due to friction and other mechanical losses are 20%. Calculate:

a. The indicated power of the engine; (4)

b. The indicated specific fuel consumption. (6)

Q-7:

REFRIGERATION

EOOW/QUESTION BANK/SCIENCE-B/REFRIGERATION

1. State FIVE desirable properties of refrigerants. (10)

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2. (a) State why some refrigerants, e.g., R 12, have been replaced. (2)

   (b) Sketch a line diagram of a vapor compression refrigeration plant, labelling each component; (4)

   (c) Describe the change of state which occurs in the condenser of the Refrigeration plant. (4)

3.

   (a) Sketch a line diagram of a simple vapor compression refrigeration plant, labelling each component and indicating refrigerant flow direction. (5)

   (b) The following readings have been taken from a system that is operating normally and uses R22 refrigerant. Indicate on the sketch drawn in Q7(a) where EACH of the readings belongs:

   (i) 0.7 bar / -21˚C / Saturation temperature: -29˚C; (1)

   (ii) 0.9 bar / Saturation temperature: -27˚C ; (1)

   (iii) 10.6 bar / 64˚C / Saturation temperature : 29˚C; (1)

   (iv) Sea water temps 20˚C and 26˚C ; (1)

   (v) 10.1 bar / 26˚C / Saturation temperature : 27˚C (1)

4.

a. State FOUR desirable properties of a refrigerant. (4)

b. Describe the change of state that occurs in the expansion value of a refrigerant plant. (3)

c. Explain what happens to the expansion value should the superheat temperature at the evaporator outlet increase. (3)

5.

a. Name four components of a simple vapor compression refrigeration Plant. (4)

b. Explain why the evaporating temperature must be lower than the ambient temperature in cold space. (2)

c. Explain why the compressor has to increase the pressure of the vapor delivered to the condenser. (4)

6.

a. State TWO desirable thermodynamic properties of a refrigerant (2)

b. Describe the state of the refrigerant at EACH of the following:

(i) inlet to the evaporator ; (2)

(ii) exit from the evaporator (2)

c. Explain why it is undesirable for any liquid refrigerant to enter the compressor. (4)

7.

a. Sketch a line diagram of a simple vapor compression refrigeration plant, labelling each component and indicating fluid flow direction. (4)

b. Explain why it is desirable for refrigerant entering a compressor to be dry, Saturated, or superheated rather than wet. (2)

c. Describe the change of state which occurs in the compressor of a refrigeration plant. (4)

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8. Describe the changes in the state of the refrigerant in a refrigeration plant that occurs under normal running conditions in EACH of the following:

a. The compressor; (3)

b. The condenser; (3)

c. The regular(expansion) valve; (2)

d. The evaporator. (2)

9.

a. State THREE desirable thermodynamics properties of a refrigerant. (3)

b. Explain why it is desirable for refrigerant entering a compressor to be dry saturated or superheated rather than wet; (3)

c. Describe the change of state which occurs in the compressor of a refrigeration plant. (4)

10.

a. Explain the reason for the phasing out of CFCs (e.g., R12) (4)

b. State ONE advantage and ONE disadvantage of ammonia as a refrigerant (4)

c. Sate TWO other gases suitable for use as a refrigerant. (2)

11.

a. Name the four components of simple vapor compression refrigeration plant. (4)

b. Explain why the evaporating temperature must be lower than the ambient temperature in the cold space. (2)

c. Explain why the compressor has to increase the pressure of the vapor delivered to the condenser. (4)

Q- 8:

HYDROSTATICS

QUESTION BANK/SCIENCE B/EOOW/HYDROSTATICS

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1. A box barge of length 50 m and breadth 10 m has a draft of 5.2 m in seawater. A cargo of 700 tonnes is now loaded, thereby increasing the even keel draft. Determine the pressure, in kN/m^2, on the outside of the bottom plating. (10)

   Take the density of sea water as 1025 Kg/m^3 and the gravitational Acceleration as 9.81m/s^2

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2. The submerged depth of an underwater vessel is 150m. The pressure on its hull is now required to be reduced to 1 MN/m^2. Calculate the distance the vessel should travel at an angle of 30° above the horizontal level to be at the specified press.

   Take the density of sea water as 1025 kg/m^3 and the gravitational acceleration as 9.81m/s^2 (10)

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3. A. Explain EACH of the following for an immersed surface:

   i) Centre of pressure (5)

   ii) Centroid. (3)

   B. Explain why the centre of pressure and centroid of an immersed surface differ in position. (2)

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4. A tank of cubical shape 10m × 10m × 10m contains oil of relative density 0.85. The tank is pressed up, and the oil rises to the sounding pipe. The total load on the bottom of the tank due to the oil is now 10006.2kN. Calculate the height of oil in the sounding pipe from the tank top.
   The gravitational acceleration is 9.81m/s^2. (10)

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5. One end of a water channel 2 m wide and 5 m deep is closed by a flap door hung from a spring-loaded hinge at the top of the channel. The channel is filled with fresh water to a depth of 3 m.
   Determine the moment on the hinge. (10)
   The gravitational acceleration is 9.81m/s^2.

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6. A rectangular tank 9.5 m long, 4.5 m wide, and 6.0 m deep contains liquid of relative density 0.86. State in percentage, how full the tank will be when the total force acting on the bottom of the tank is 1298.4 kN
   Take the gravitational acceleration as 9.81m/s^2. (10)

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7. A ballast tank and an oil tank are separated by a rectangular vertical bulkhead 8m wide. The oil tank contains oil of relative density 0.88 to a depth of 5.2 m, and the ballast tank contains sea water of density 1025 kg/m^3. The resultant thrust is 1329 kN from seawater to the oil side.
   Gravitational acceleration is 9.81m/s^2.
   Calculate the depth of the seawater in the ballast tank. (10)

8. The pressure due to the water on a rectangular dock gate varies linearly with the depth of water, ‘d,’ showing a triangular shape of the distribution. The centre of pressure on the dock gate acts at the centroid of this triangle. State, with reasons, the distance between the centroid and the centre of pressure on the dock gate in terms of the water depth, ‘d.’ (10)

9. A rectangular tank 9.5m long, 4.5m wide, and 6.0m deep contains liquid of relative density 0.86. Calculate the total force acting on the bottom of the tank when the tank is 60% full.

Take the gravitational acceleration as $9.81 m/s^2$. (10)

10. Explain why the centre of pressure due to liquid acting on a vertical water-tight bulkhead is always lower than the centroid of the immersed surface of the bulkhead. (10)

11. A rectangular dock gate 20m wide is holding river water of density $1015 kg/m^3$ on one side only. Calculate the force acting on the gate when the water reaches a height of 10.5m.

Take the gravitational acceleration as $9.81 m/s^2$. (10)

12. A box barge of length 50 m and breadth 10 m has a draft of 5.2 m in seawater.

A cargo of 1025 tonnes is now loaded, thereby increasing the even keel draft.

Determine the pressure, in kN/m^2, on the outside of the bottom plating

Take the density of sea water as $1025 Kg/m^3$ and the gravitational acceleration as $9.81 m/s^2$ (10)

Q- 9:

ARCHIMEDES' PRINCIPLE

QUESTION BANK/SCIENCE B/ EOOW/ARCHIMEDES' PRINCIPLE

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1. a. State Archimedes' principle (4)

   b. Some bodies float when placed on a fluid, while others sink. Describe why this is so.

   Give examples to demonstrate your answer. (6)

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2. A rectangular box barge of 20m beam and 40m long displaces 250 tonnes when empty. The maximum draft of the barge is 4.5m. Sea water SG=1.025

   Calculate:

a. the maximum weight of cargo that can be carried on a sea passage. (6)

b. the weight of cargo that would have to be removed from Q9(a) before a river passage. (4)

   [NOTE: RIVER WATER DENSITY IS NOT GIVEN IN THIS QUESTION; SO, WE CAN ASSUME THE DENSITY OF RIVER WATER AS 1015kg/m^3]

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3. Explain, with reference to Archimedes' principle, how a ship constructed of steel with a much greater density than water, can float in water. (10)

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4. A loaded rectangular box barge has a draft of 6 m and a displacement of 3000 m^3 whilst floating in seawater. The barge is to be moved to a river berth to discharge cargo. The depth of water available at the berth is 5.8 m. The density of seawater = 1025 kg/m^3; river water = 1005 kg/m^3

   Calculate the required change in ballast in tonnes. (10)

---

5. A rectangular pontoon barge of 20 m beam and 20.3 m long displaces 3000 tonnes in fresh water. The barge is to be moved to a seawater berth where The SG of the water is 1.025. Assuming the barge floats evenly, Calculate:

a. the volume of the barge up to the water line in freshwater; (3)

b. the draught of the barge in freshwater; (3)

c. the weight that must be added to maintain the same draught when the barge is moved to the seawater berth. (4)

---

6. a. State Archimedes' principle. (3)

b. The volume of a body, having an irregular shape, is to be determined. In seawater, it has an apparent mass of 151.9 kg, but in the air, the mass is 244.9 kg. Calculate the density of this object. (7)

Take the density of seawater as $1025 kg/m^3$ and the gravitational acceleration as $9.81 m/s^2$

---

7. A. Arrange the following materials in order of increasing density:

Steel; water; aluminium; balsa wood; mercury (2)

B. Explain, with reference to Archimedes' principle, how a material that normally sinks in water can be made to float. (8)

---

8. A floating crane based on a rectangular pontoon measuring 30 m by 25 m displaces 1500 tonnes. The barge is to be moved from a location in a river, where the density of the water is 1010 kg/m^3, to a location in an estuary, where the density of the water is 1025 kg/m3. The freeboard of the pontoon is to be maintained by the introduction of concrete ballast to compensate for the move to the estuarial location.

Calculate:

a. The volume of the pontoon up to the water line in river water; (3)

b. The draught of the pontoon whilst in the river; (3)

c. The volume of concrete required to maintain the freeboard when in the estuary. (Concrete density = 2300 kg/m^3) (4)

---

9. A rectangular pontoon of 30 m beam and 60 m long displaces 250 tonnes. The barge is loaded with 500 tonnes of cargo whilst in river water and then undergoes a sea voyage. SG of seawater is 1.025; SG of river water is 1.002. Assuming the barge floats evenly, calculate the change in the draft:

a. during loading; (7)

b. when moving from river to sea. (3)

10.

a. State Archimedes' principle. (3)

b. The volume of a body, having an irregular shape, is to be determined. In seawater, it has an apparent mass of 2.55 kg, but in the air, the mass is 3.57 kg. Calculate the volume of this object. (7)

Take the density of seawater as 1025kg/m^3 and the gravitational acceleration as 9.81m/s^2

11. A rectangular pontoon barge of 20 m beam and 20.3 m long displaces 2500 tonnes in seawater with SG = 1.025. The barge floats evenly and has a Freeboard of 2.5 m in this condition of the barge;

(a) The volume of the barge up to the water line; (3)

(b) The draught of the barge; (3)

(c) The weight to be added to reduce the freeboard to 0.5m. (4)

Q- 10:

D.C. CIRCUIT

QUESTION BANK/SCIENCE B/ EOO/D.C. CIRCUIT

1. For the circuit diagram in figure Q10, calculate:
   a. The value of the current flowing through each resistor; (5)
   b. The value of the resistor R_2; (3)
   c. The circuit current if the two resistors were placed in series. (2)

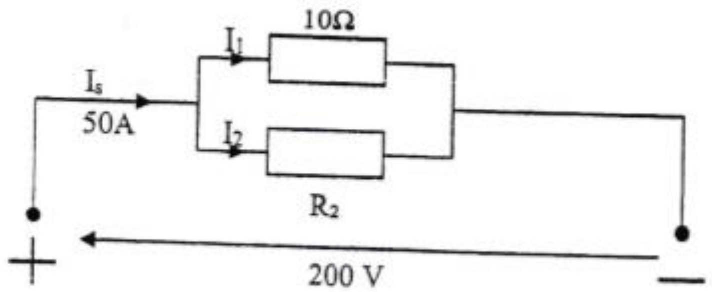


Figure Q10

2. For the circuit shown in Fig Q10, calculate:
   a. The total circuit resistance; (2)
   b. The total circuit current, Is (2)
   c. The potential difference across parallel branches (2)
   d. Current in the 10 Ω and 15 Ω resistors (2)

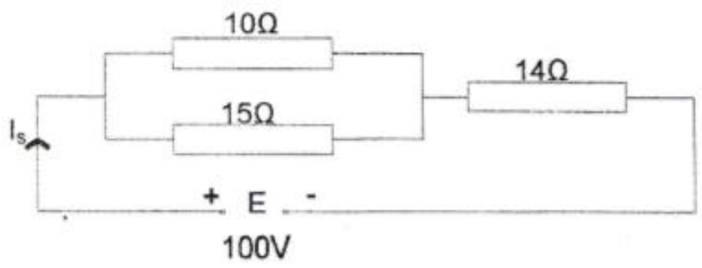
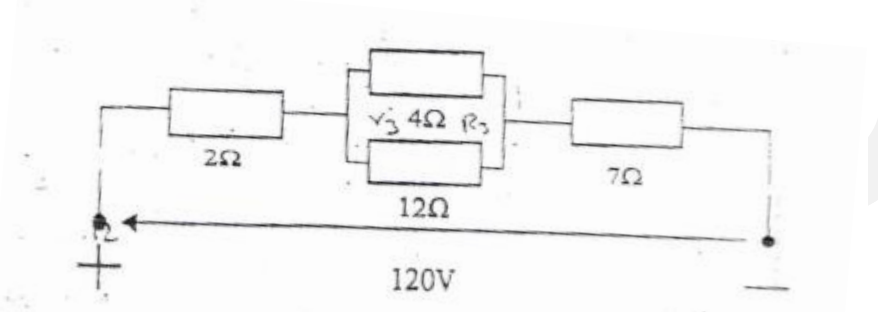
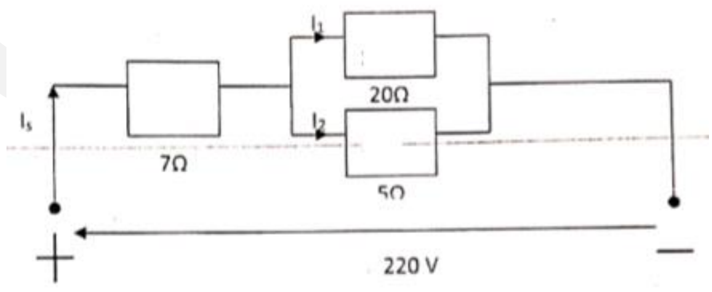


Fig Q10

3. For the circuit diagram below shown in Fig10.
   a. The total circuit resistance, Rt; (3)
   b. The circuit current, Is; (2)
   c. The potential difference across the 7 Ω resistor; (2)
   d. What would the circuit current be if the 4 Ω resistors would open circuit? (3)



4. For the circuit diagram in figure Q10, Calculate:
   a. The supply current, Is (4)
   b. Potential difference across 7 Ω resistor; (2)
   c. Current through 20 Ω resistor; (4)



5. In the circuit in Fig Q10, the potential difference across the 10 Ω resistor is 30 V. Calculate:
   a. The total circuit current, Is; (3)
   b. The current through the 15 Ω resistor ; (5)
   c. The e.m.f. E, of the circuit. (2)

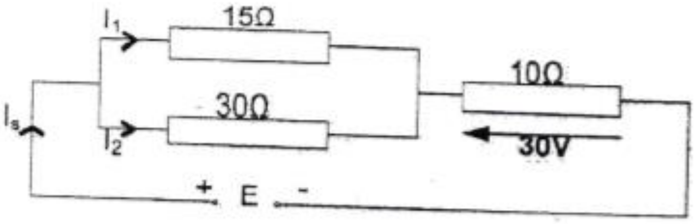


Fig Q10

6. Figure Q 11 shows two 12 V lamps, each of 4 Ω resistance, connected in parallel across a 20 V supply.
   To avoid exceeding the current rating for the lamps, a resistor of 1.33 Ω is connected in series with the supply.
   Calculate:
   a. The power dissipated by each lamp ; (5)
   b. The power dissipated by the 1.33 Ω resistor ; (2)
   c. The total energy used by the circuit in 30 minutes. (3)

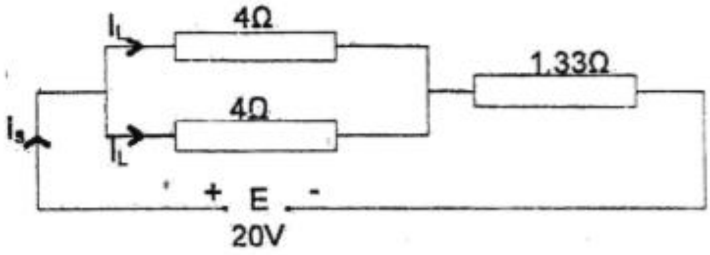


Figure Q11

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7. The circuit shown in Figure Q 11 is connected across a 36 V supply. The power dissipated in the network is 540 W.

   Calculate:

   a. The value of the unknown resistor R; (6)

   b. The power dissipated by the resistor ; (2)

   c. The total energy consumed by the circuit in 2 hours. (2)

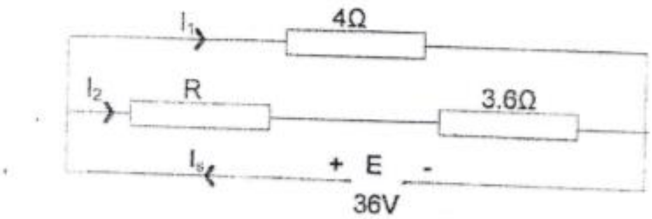

Figure Q11

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8. Two resistors of 10 Ω and 30 Ω, respectively, are connected in series across a 240 V supply. Calculate the supply current when a single 60 Ω resistor is connected in parallel with:

(a) the 30 Ω resistor only; (5)

(b) the 10 Ω and 30 Ω resistors in series. (5)

9. The navigation lights on a vessel are fed from a DC supply. Three lights are connected in parallel, and each draws a current of 5A. The lamps have a resistance of 3 Ω each.

Calculate:

(a) the power dissipated by each lamp; (2)

(b) the total power consumed by the circuit if the total resistance of the cables were 0.6 Ω; (6)

(c) the supply voltage. (2)

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TOPIC NO 11_Q 11_TEMPERATURE DEPENDENCY OF RESISTORS

QUESTION BANK/SCIENCE B/ EOOW/TEMPERATURE DEPENDENCY OF RESISTORS

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1. The copper stator windings of a generator have a resistance of 20 Ω at a temperature of 0°C. When the temperature rises to 15°C, the resistance then measures 20.9Ω.

Calculate:

(a) the temperature coefficient of resistance (α) for the copper; (6)

(b) the resistance of the windings when the temperature rises to 100°C. (4)

---

2. The resistance of the (copper) stator windings of a motor is measured and found to be 240Ω at 15°C. The motor is then allowed to warm up, the electrical supply is then isolated, and another measurement is taken of the stator's windings resistance. The temperature for the second measurement is 65.5°C, and the temperature coefficient of resistance (α) for copper at 0°C is 0.0042/°C:

(a) Calculate the value of resistance at this new temperature. (6)

(b) Draw a graph showing how you would expect resistance to change when conductors are heated for EACH of the following:

(i) pure metals; (2)

(ii) special alloys. (2)

TOPIC NO 11_Q 11HEATERS AND FURNACE NUMERICALS

QUESTION BANK/SCIENCE B/HEATER/FURNACE

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1. (a) A domestic electric kettle is fed from a 220V power supply. The heating element has a resistance of 120Ω.
Calculate the time taken to boil 750ml of water from a temperature of 6°C. (10)
Take the specific heat capacity of water to be 4.2kJ/kg°C.

---

2. A hot-water cylinder has a capacity of 5 liters of fresh water. The heating element of the cylinder has a resistance of 20Ω and it is connected to a 240V supply.
The specific heat capacity of water is 4.2kJ/kg°C, and the initial temperature of the water is 6°C.
Calculate:
(a) the time taken for the water to reach a temperature of 80°C; (8)
(b) the heater element current. (2)

---

3. An electric furnace is used to melt a brass rod which has a mass of 500kg. The furnace is rated at 200Kw, and it is fed from a 440V supply.
The initial temperature of the brass is 6°C, and the melting point of brass is 910°C. There is no heat loss from the furnace, and the specific heat capacity of brass is 0.39kJ/kg°C.
Calculate:
(a) the time it takes to melt the brass; (8)
(b) the furnace heater current. (2)

---

4. An electric furnace is required to expand a brass bearing of mass 4 kg to fit the shaft of a motor. The furnace is rated at 15 kW and is fed from a 440V supply. The initial temperature of the brass is 10°C and it is required to raise its temperature to 400°C.

The specific heat capacity of brass is 0.39 kJ/kg°C. Assuming no heat is lost in the process, Calculate:

a. the time taken to raise the brass to the required temperature; (8)

b. the current drawn by the furnace (2)

TOPIC NO 12_Q12_A.C. CIRCUIT

QUESTION BANK/SCIENCE B/A.C. CIRCUIT

1. A coil has an inductance of 0.025H and a resistance of R Ω; when connected to a supply voltage of 240 V, 50Hz, a current of 15A flows through the coil.

Calculate:

a. the resistance of the coil ; (5)

b. the power of the coil (State whether leading or lagging); (2)

the true power, apparent power, and reactive power of the coil. (3)

2. An AC circuit is made up of a coil connected in series with a 100μF capacitor. The coil has a resistance of 20 Ω and an inductance of 0.08H. If the circuit is connected to a 240V, 50 Hz supply.

Calculate:

a. the circuit current; (6)

b. The circuit power factor (whether leading or lagging) (2)

c. the frequency at which the circuit would be in resonance. (2)

3. The circuit comprises a coil (resistance 10 Ω) and a capacitor connected in series. The inductive reactance (X_L) of the circuit of 31.4 Ω, and the capacitive reactance (X_C) is 21.2 Ω. The supply voltage is 240V, 50Hz.

Calculate:

a. the circuit impedance Z; (2)

b. the circuit current I; (2)

c. the circuit power factor; (2)

d. the voltage across the capacitor; (2)

e., the voltage magnification factor. (2)

4. For the circuit shown in Figure Q 12 calculate:

a. the resonant frequency; (4)

b. the impedance at resonance; (4)

c. the circuit current at resonance. . (2)

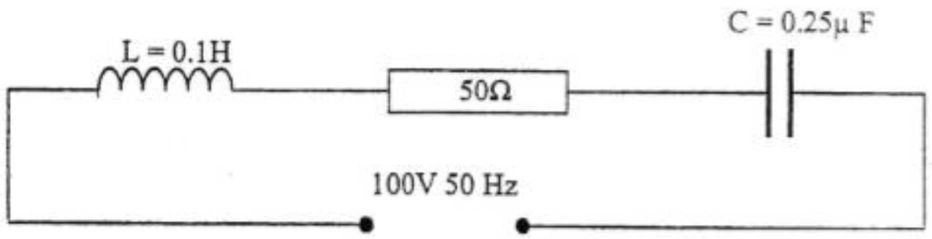

Figure Q12

5. A coil of 0.25H inductance and 25 Ω resistance is connected in series with a capacitor C. The supply voltage is 20V at a frequency of 100Hz.

If the circuit is resonant at this frequency, calculate:

a. the supply current; (2)

b. the reactance of the capacitor; (4)

c. the voltage across the capacitor; (2)

d. the voltage magnification Q, of the circuit (2)

6. A coil of 1.013H inductance and 10 Ω resistance is connected in series with a 10 μF capacitor;

Calculate:

a. the resonant frequency of the circuit; (3)

b. the circuit current when connected to a 240V a.c. supply at the resonance frequency; (2)

c. the potential difference developed across the capacitor; (3)

d. the circuit power factor. (2)

---

7. A coil of 8 Ω resistance and 0.15H inductance is connected in series with a 100 μF capacitor across a 240V, 50Hz a.c. supply.

Calculate:

a. the circuit current; (5)

b. the power factor of the circuit (State whether leading or lagging); (2)

c. the potential difference across the capacitor; (1)

d. the voltage magnification factor of the capacitor. (2)

---

8. A coil of 0.5H inductance and 70 Ω resistance is connected in series with a 15 μF capacitor. The current flowing through the circuit is 0.25A. when the supply frequency is 50Hz.

Calculate:

a. the circuit impedance; (6)

b. the supply voltage E; (2)

c. the power factor of the circuit (State whether leading or lagging) (2)

---

9. A coil has a resistance of 10 Ω and an inductance of 0.1H. It is connected in series with a 150 µF capacitor and across a supply voltage of 200V 50Hz. Calculate:

a. the circuit impedance Z; (4)

b. the circuit current I; (2)

c. draw the impedance triangle; (2)

d. the circuit power factor (2)

---

10. A single-phase AC motor operating off a 240 V 50Hz supply is developing 2 KW. It has an efficiency of 84% and a power factor of 0.7 lagging.

Calculate:

a. the input apparent power; (5)

b. the load current; (2)

c. the reactive power (kVAr) (3)

---

11. An a.c. motor operating at an efficiency of 85% and a power factor of 0.8 lagging is driven by an a.c. supply of 440V, 50Hz. The motor is delivering 4kW to the load.

Calculate:

a. the input power in kW; (3)

b. the input apparent power in KVA; (2)

c. the input reactive power Q in kVAr; (3)

d. the supply current to the motor. (2)

---

12. The input power to an induction motor under full load condition is 2kW with a power factor of 0.7 lagging. The supply voltage is 240V at 50Hz.

a. Calculate:

i) the supply current flowing into the motor; (2)

ii) the kVA rating required for the motor. (2)

b. The power factor is then improved to 0.9 lagging.

Calculate:

i) the reduction in the current flowing into the motor; (3)

ii) the reduction in kVA rating required. (3)

---

13. A motor draws a load current of 15A when connected to a 240V 50Hz AC supply. The resistance of the windings is measured and found to be 12.8 Ω and their total impedance is 16 Ω.

Calculate:

a. the apparent power; (2)

b. the power factor (State whether lagging or leading); (4)

c. the true power; (4)

---

14. An alternator is supplying 300kW at a power factor of 0.6 lagging. Calculate:

a. the kVA rating required; (2)

b. the kVAr produced; (2)

c. the reduction of kVAr when the power factor is increased to 0.9 lag.

for the same kVA rating. (3)

d. the increase in KW when the power factor is increased to 0.9 lag. (3)