UK MCA General Engineering Science II Syllabus

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General Engineering Science II Exam

For: Second Engineer <3000kW / Class 1 Fishing Engineer / Yacht 2 Chief Engineer (Y2)

LIST OF TOPICS

HEATENGINES

1. Heat Energy
2. Gas Laws
3. Combustion
4. Refrigeration

ELECTROTECHNOLOGY

5. Nature of Electricity
6. Electric Currents
7. Electric Circuits
8. Resistance
9. Secondary Cells
10. Magnetic Field
11. Electromagnetic Induction
12. Measuring Instruments and Measurements

HEATENGINES

1 Heat Energy

Solves problems involving mass, specific heat capacity and temperature change.

1.1 Describes fuels as sources of energy.

1.2 States that heat being a form of energy, the unit for quantity of heat is the joule.

1.3 States that temperature differential decides the direction of transfer of heat energy.

1.4 Distinguishes between temperature and heat energy.

1.5 Defines the fixed points on the Celsius scale of temperature.

1.6 Defines a change in enthalpy without change of state (ie sensible heat).

1.7 Defines specific heat capacity.

1.8 States that a unit of specific heat capacity is the kJ/kg K..

1.9 Solves simple problems associated with mass, specific heat capacity and temperature change.

1.10 Defines conduction, convection and radiation.

1.11 Gives one example in each case of the transfer of heat energy by each of the processes given in 1.10

1.12 Discusses the use of insulation to conserve fuel in a heating installation.

1.13 Appreciates the effects of heat energy supplied to solids, liquids and gases.

1.14 Discusses expansion and contraction of solids and liquids and the practical application of thermal expansion and contraction.

1.14 Derives the relationship between temperature and the increase of linear dimensions of solids and volumetric dimensions of liquids.

1.16 Defines coefficient of linear expansion.

1.17 Derives coefficients of superficial and cubical expansions.

1.18 Distinguishes between real and apparent expansion of a liquid.

1.19 Solves problems relating change of temperature and change of dimensions of solids and liquids.

1.20 Defines specific heat capacity without reference to constant volume or constant pressure.

1.21 Solves problems involving heat and cooling of solids and liquids, relating heat energy and temperature.

1.22 Describes how changes of state occur without change in temperature.

1.23 Defines boiling and freezing points.

1.24 Defines specific enthalpy of fusion and specific enthalpy of evaporation.

1.25 Solves problems involving mixtures of solids and liquids, liquids and liquids, liquids and vapours.

1.26 Describes the following temperature measuring devices:

(a) a liquid in glass thermometer;

(b) thermocouple;

(c) pyrometer.

2 Gas Laws

2.1 Defines an ideal or perfect gas.

2.2 Defines Boyle's Law.

2.3 Defines Charles' Law.

2.4 Derives absolute zero temperature and relays Kelvin scale to the Celsius scale of temperature.

2.5 Derives the combination of

$$\frac{PV}{T} = C$$

2.6 States that gas laws in the forms pV = mRT when R is the specific gas constant.

2.7 Defines the units of R.

2.8 States the meaning of standard temperature pressure (STP) and normal temperature pressure (NTP).

2.9 Solves problems involving pressure, volume, temperature and mass.

3 Combustion

3.1 Defines a fuel and the types of fuels available.

3.2 Defines combustion.

3.3 Gives the chemical symbols of the elements and compounds associated with combustion.

3.4 Gives meanings of suffix and prefix numbers applied to chemical symbols.

3.5 Develops combustion equations for hydrogen, carbon, sulphur.

3.6 Defines higher and lower calorific values of a fuel.

3.7 Determines combustion analysis by mass.

3.8 Determines theoretical or stoichiometric air requirements for complete combustion of a fuel by mass.

3.9 Defines excess air supply.

3.10 Discusses the effect of excess and inadequate air supply in relation to boilers and internal combustion engines.

3.11 Defines the following engine power:

(a) indicated power;

(b) brake power;

(c) friction power;

(d) cooling water power;

(e) exhaust power.

3.12 Determines mean effective pressure from an indicator card.

3.13 Derives formula for indicated power in relation to single acting engines operating on two and four stroke cycles.

3.14 Defines indicated and brake mean effective pressures.

3.15 Defines specific fuel consumption.

3.16 Defines the following engine efficiencies:

(a) mechanical efficiency;

(b) indicated thermal efficiency;

(c) brake thermal efficiency.

3.17 Solves problems involving two stroke and four stroke IC engines.

4 Refrigeration

4.1 States the properties of a refrigerant.

4.2 Describes the basic refrigerant circuit for a compression type domestic refrigeration plant.

4.3 States the condition of the refrigerant at the various points in the circuit.

ELECTROTECHNOLOGY

5 Nature of Electricity.

5.1 Describes the structure of the atom and defines electron, proton and neutron.

5.2 Describes the shells of electrons in the atom and the detachment of a loosely held electron by some influence.

5.3 States that the free movement of electrons gives a current of electricity.

5.4 States that, for unidirectional continuous current, free electrons must be available in all parts of a circuit.

5.5 Defines the terms "conductor" and "insulator" and gives three examples of each.

5.6 States that all conductors offer some resistance to the flow of electric current.

5.7 Names secondary cells and generators, as sources of electricity.

5.8 Uses preferred symbols appropriate for the representation of sources, cells and resistors, and switches in an electric circuit.

6 Electric Current

Identifies the three main effects of an electric current.

6.1 States examples of an electric current being used for its magnetic effect.

6.2 States examples of an electric current being used for its chemical effect.

6.3 States examples of an electric current being used for its heating effect.

6.4 Identifies the effect being made use of in given specific cases. Example electromagnet, electroplating, electric fire, fuse.

7 Electric Circuits

Solves problems associated with simple electrical circuits.

7.1 States that the SI unit for current is the ampere.

7.2 States that one ampere is one coulomb per second, that a coulomb is the unit for quantity of electricity and that a coulomb is composed of a specific and very large number of electrons.

7.3 Explains how a current flows due to the existence of a potential difference between two points in an electrical conductor.

7.4 Defines potential difference and states that the unit is the volt.

7.5 Defines electromotive force and states that the unit is the volt.

7.6 States that watts equals volts multiplied by amperes.

7.7 States ohms Law in terms of the proportionality of current to potential difference.

7.8 States that this constant of proportionality for a particular resistor is called the resistance and that the unit of resistance is the ohm.

7.9 Solves simple problems using Ohm's Law.

7.10 Describes a series circuit as one which provides only one path for the flow of current through the circuit.

7.11 Describes a parallel circuit as one which provides alternative paths for the flow of current through the circuit.

7.12 States that the current is the same in all parts of a series circuit.

7.13 States that the sum of the voltages in an external series circuit is equal to the total applied voltage.

7.14 Shows that for resistors connected in series the equivalent resistance is given by $R = R1 + R2 + R3\ldots$

7.15 Solves simple problems involving up to three resistors connected in series, including the use of Ohm's Law.

7.16 States that the sum of the current in resistors connected in parallel is equal to the current flowing into the parallel network.

7.17 States that the potential difference (voltage) is the same across resistors in parallel.

7.18 Shows that for resistors connected in parallel the equivalent resistance is given by:

$$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}\ldots..$$

7.19 Solves simple problems involving up to three resistors connected in parallel by use of Ohm's Law.

7.20 States that power dissipated in a given conductor is the product of a potential difference and the current.

7.21 Uses Ohm's Law to show that

$$P = I^2R \text{ or } \frac{V^2}{R}$$

7.22 Calculates the power dissipated in simple circuits.

8 Resistance

Solves problems involving resistance variation with temperature and resistivity.

8.1 States the effect of temperature increase on the resistance of metals, carbon, electrolytes and insulation.

8.2 Defines the temperature coefficient of resistance.

8.3 Solves simple problems involving the temperature coefficient of resistance.

8.4 Defines resistivity.

8.5 Solves simple problems involving resistivity.

Is aware of the concepts of e.m.f. and internal resistance.

8.6 Describes the potential difference (voltage) of a source on no load as the e.m.f.

8.7 Defines internal resistance.

8.8 Explains the effect of load current on terminal p.d. and hence determines internal resistance.

9 Secondary Cells

9.1 Explains difference between primary and secondary cells.

9.2 Describes the chemical changes during the charging and discharging of a simple lead-cell.

9.3 Describes how, using a high resistance voltmeter, the e.m.f. of charged lead-acid cells is measured:

(a) singly;

(b) in series;

(c) in parallel.

9.4 Explains the effects of load current on terminal p.d. and hence determines internal resistance of cells.

9.5 Labels, given diagram, the mains parts of:

(a) lead-acid cells;

(b) alkaline cells.

9.6 States that the capacity of a cell is measured in ampere hours.

10 The Magnetic Field

10.1 Defines the terms flux, flux density, m.m.f., and magnetizing force.

10.2 Recognises the effects of ferromagnetic materials on flux density.

10.3 States the units of B, H, m.m.f.

11 Electromagnetic Induction

11.1 States Lenz's Law.

11.2 States Faraday's Laws of electromagnetic induction.

11.3 Explains the motor principle in terms of the interaction between two magnetic fields.

11.4 Explains the function of the commutator.

11.5 Recognises from the formula F = BIL, the linear relationship between F and the other terms.

11.6 Explains the generator principle in terms of Faraday's Laws and Lenz's Law.

11.7 Recognises the linear relationship between E and the other terms from the formulae E - BLv.

11.8 Describes production of an induced e.m.f. due to a change in magnetic field.

12 Measuring Instruments and Measurements

12.1 Describes with the aid of given diagrams, the principles of operation of:

(a) moving iron;

(b) moving coil instruments.

12.2 Explains the needs for shunts and multipliers to extend the range of a basic electrical indicating instrument.
