CONSTRUCTION AND PROPERTIES OF SINGLE PHASE AC MOTORS

SINGLE PHASE MOTORS

- STARTING WINDING
- RUNNING WINDING

- STARTING WINDING FLUX AND RUNNING WINDING FLUXES ARE 90° PHASE DIFFERENCE.
- STARTING WINDING NEEDS TO BE CUT OFF ONCE THE MOTOR IS ACCELERATED.

SINGLE PHASE MOTORS

- SPLIT PHASE
- CAPACITOR START
- CAPACITOR START CAPACITOR RUN
- UNIVERSAL
- SHADED POLES
- HYSTERESIS

STATOR

THE LAMINATED STATOR CORE IS MADE FROM SHEET STEEL STAMPING WITH SLOTS ON THE INNER SURFACE.

THE STATOR CORE IS HELD IN THE MOTOR FRAME WHICH ALSO SERVES TO CARRY THE BEARING HOLDING ON THE ROTOR TO PROTECT THE COILS AND TO PROVIDE A MEANS WHERE BY THE WHOLE CAN BE MOUNTED.

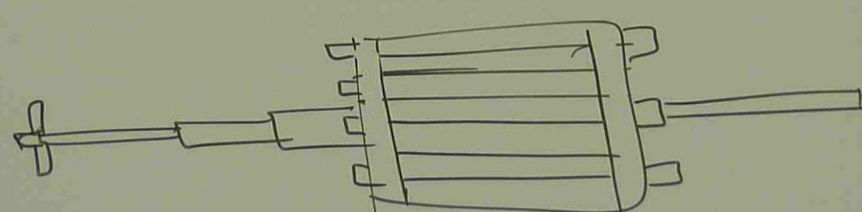
THE MOTOR FRAME TAKES VARIOUS FORMS, DEPENDING ON THE CONDITIONS UNDER WHICH THE MOTOR WILL OPERATE. AN OPEN TYPE FRAME ALLOWS FREE VENTILATION, A DRIP PROOF FRAME HAS A CLOSED UPPER HALF WHILE ALLOWING VENTILATION THROUGH THE LOWER PART.

A TOTALLY ENCLOSED TYPE PREVENTS THE EXCHANGE OF AIR BETWEEN INSIDE AND OUTSIDE OF FRAME.

ROTOR

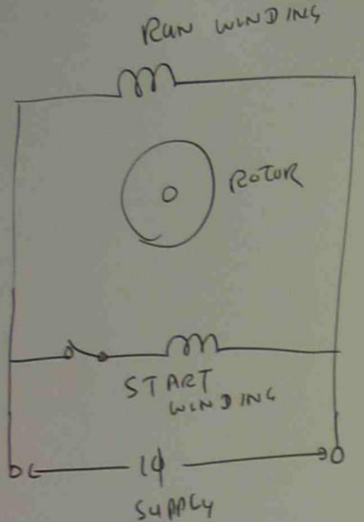
SQUIRREL CAGE ROTOR

THE ROTOR OF AN INDUCTION MOTOR CONSISTS OF A SHAFT WITH BEARINGS, LAMINATED IRON CORE AND ROTOR CONDUCTORS. THE MOST COMMON TYPE OF CONSTRUCTION IS THAT WITH ROTOR BARS IN THE LAMINATION SLOTS RATHER THAN A WINDING. THE ROTOR BARS SHORT CIRCUITED AT EACH END BY A SOLID RING ARE OFTEN MADE OF COPPER STRIPS WELDED TO COPPER RINGS. BUT FOR SMALL TO MEDIUM SIZE MOTORS, THEY MAY BE CAST IN ONE PIECE OUT OF ALUMINIUM

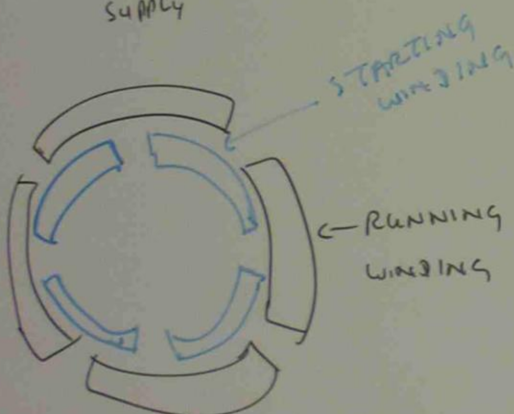


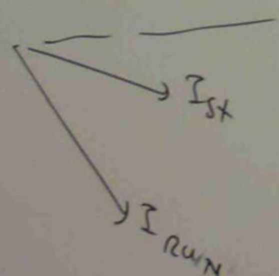
ROTATION → CROSS MAGNETIZING FLUX

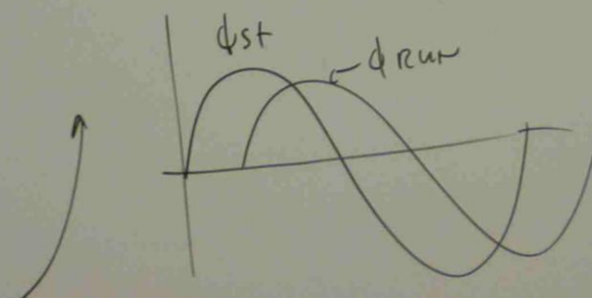
ROTATION → REVOLVING FIELD



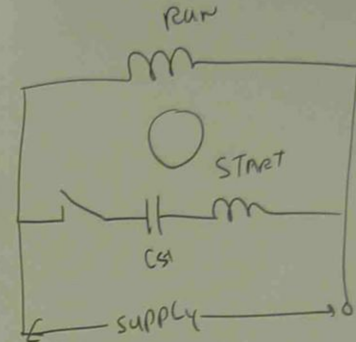
SPLIT PHASE MOTOR





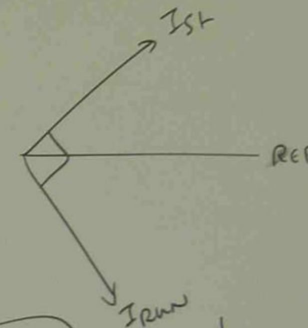


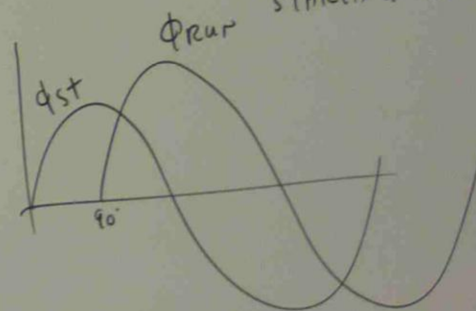
CAPACITOR START MOTOR



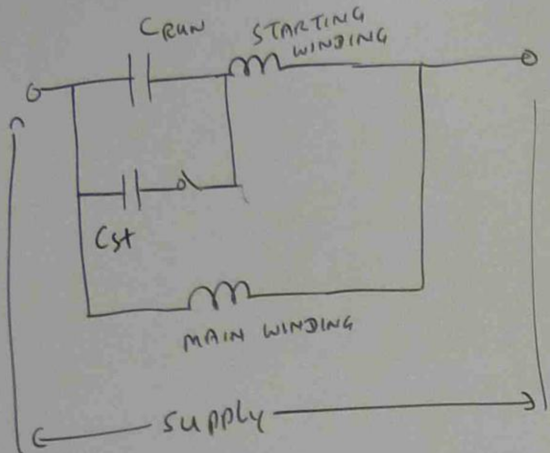
C_{st} = STARTING CAPACITOR

STARTING CAPACITOR PROVIDES 90 DEGREE PHASE DIFFERENCE BETWEEN STARTING & RUNNING FLUXES AND CURRENTS AND PROVIDES HIGHER STARTING TORQUE

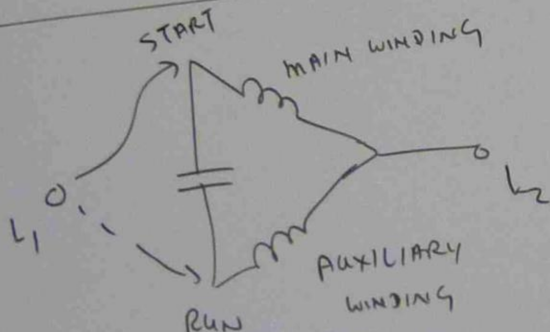




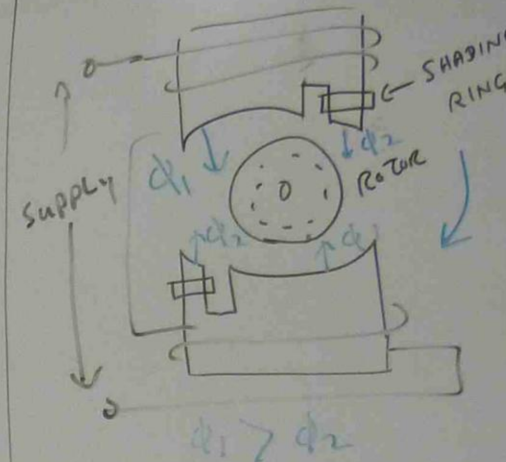
CAPACITOR START | CAPACITOR RUN MOTOR

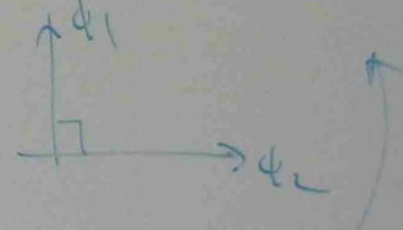


PERMANENTLY SPLIT CAPACITOR MOTOR

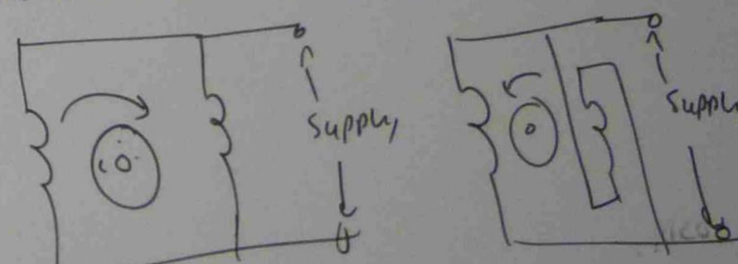


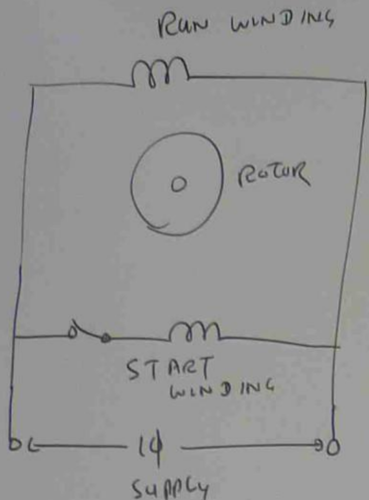
SHADED POLE MOTOR



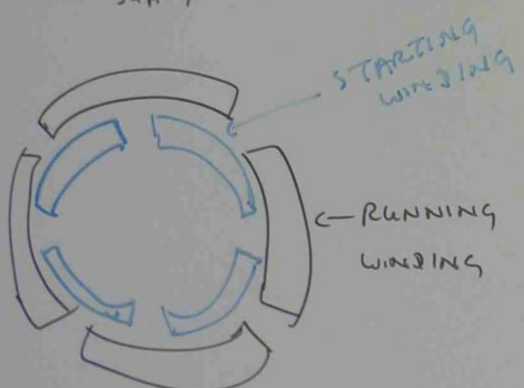


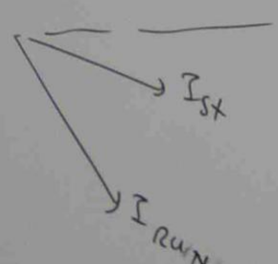
REVERSING MOTOR ROTATION

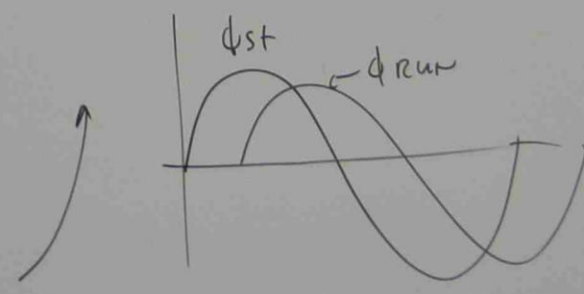




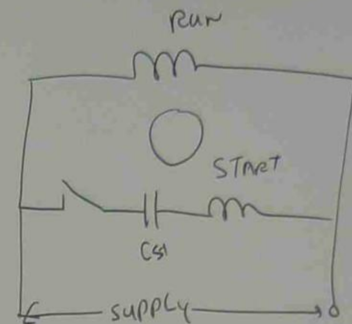
SPLIT PHASE MOTOR







CAPACITOR START MOTOR



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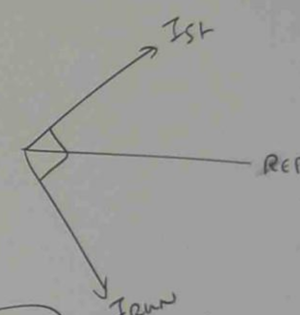
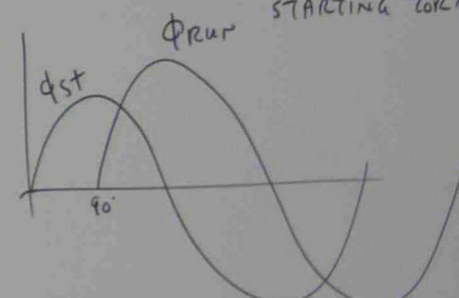
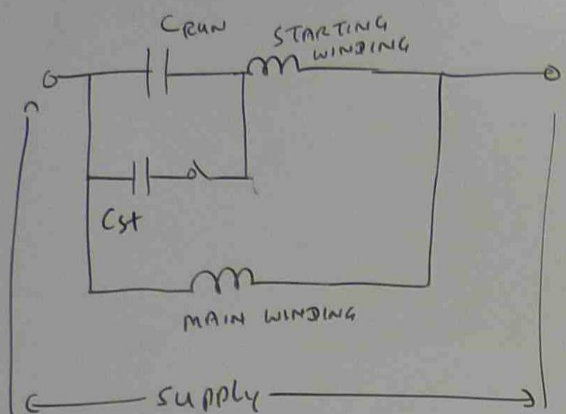
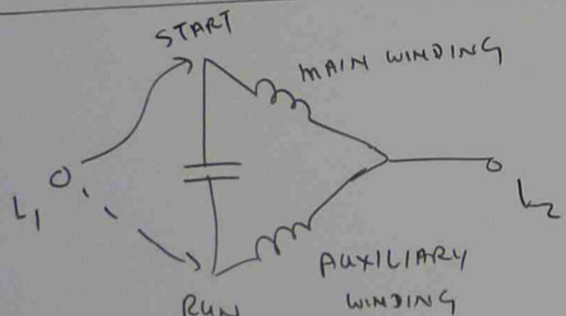




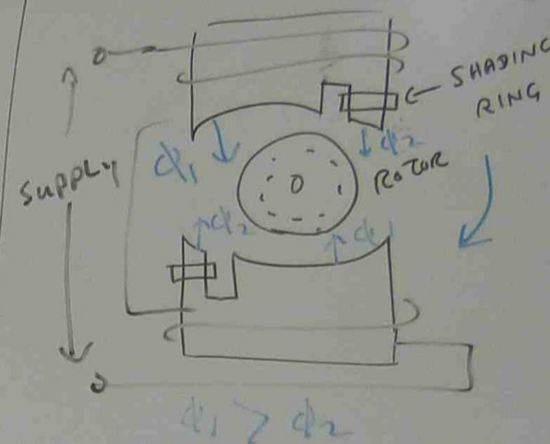
CAPACITOR START | CAPACITOR RUN MOTOR

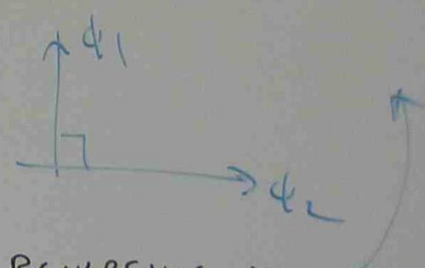


PERMANENTLY SPLIT CAPACITOR MOTOR

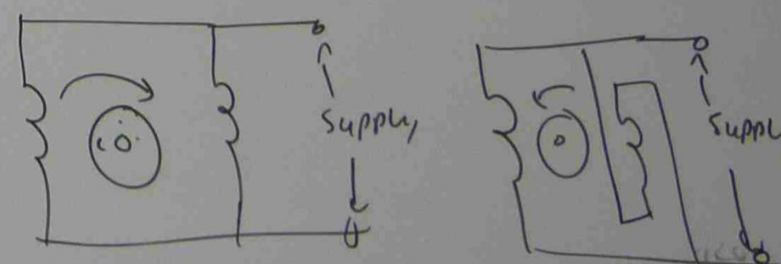


SHADED POLE MOTOR





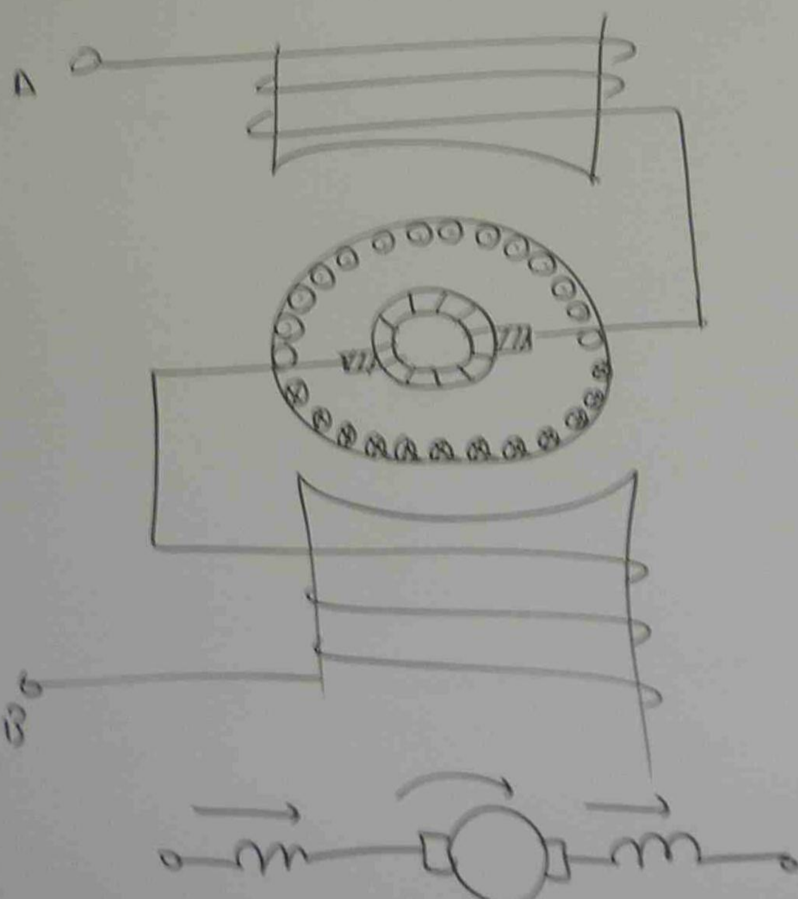
REVERSING MOTOR ROTATION

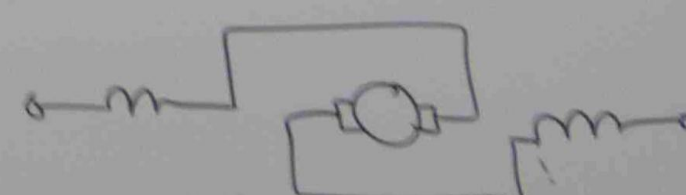


UNIVERSAL MOTOR

OTHER AC MOTORS $N = \frac{120f}{P}$

MAXIMUM SPEED = 3000 RPM





COMP

ADVAN

SMAL

HIGH

SUITA

NO

NO

I

COMPARISON OF 1ϕ & 3ϕ MOTORS

ADVANTAGES OF 3ϕ MOTOR

SMALLER SIZE

HIGHER EFFICIENCY

SUITABLE FOR POWER LINE FREQUENCY

NO STARTING MECHANISM IS REQUIRED

NO ADDITIONAL WIRING IS REQUIRED

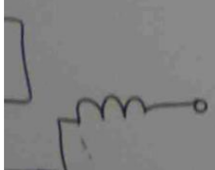
DISADVANTAGES OF 3ϕ MOTORS

THREE IDENTICAL WINDINGS ARE REQUIRED.

ADVANTAGES OF 1ϕ MOTOR

ONLY TWO WINDINGS.

ONLY ACTIVE AND NEUTRAL CONDUCTORS ARE NEEDED.



DISADVANTAGES OF 1ϕ MOTOR

HIGHER CURRENT

MORE EXPENSIVE FOR LARGER SIZES

APPLICATIONS

3ϕ MOTORS — INDUSTRIAL APPLICATIONS

1ϕ MOTOR — DOMESTIC APPLICATIONS

ABNORMAL OPERATIONS FOR 3ϕ MOTORS

TO RUN MOTOR SMOOTHLY, THE FOLLOWINGS ARE REQUIRED.

- THREE EQUAL VOLTAGES AT CORRECT PHASE DISPLACEMENT
- STATOR WINDING BEING CORRECTLY CONNECTED IN EITHER STAR (OR) DELTA CONFIGURATION.
- THREE LINE VOLTAGES BEING CONNECTED TO THE MOTOR WINDINGS.

CAUSE OF ABNORMAL OPERATION

PHASE REVERSAL	FREQUENCY VARIATION
SINGLE PHASING	FREQUENT STARTING
OVERLOADING	MISALIGNMENT OF SHAFT
VOLTAGE FLUCTUATION	JAMMING OF BEARINGS
HIGHER OPERATING TEMPERATURE	BLOCKING OF VENTILATION DUCTS
	OVERHEATING

MOTOR MAINTENANCE

ELECTRICAL TESTS FOR 3φ MOTOR WINDINGS

- CONTINUITY TEST
- INSULATION TO EARTH TEST
- INSULATION TEST BETWEEN WINDINGS
- VISUAL INSPECTION
- REGULAR INSULATION UPGRADING
- WINDING RESISTANCE TEST

REWINDING

COIL SPAN, COIL GROUPS, NUMBER OF CONDUCTORS, SIZE OF CONDUCTORS, CONNECTION, WINDING RESISTANCE ARE TO BE RECORDED FOR MAKING AN IDENTICAL WINDING

TORQUE AND HORSE POWER

$$HP = \frac{\text{SPEED (RPM)} \times 2\pi\ \text{TORQUE}}{33\,000}$$

LOCKED ROTOR TORQUE

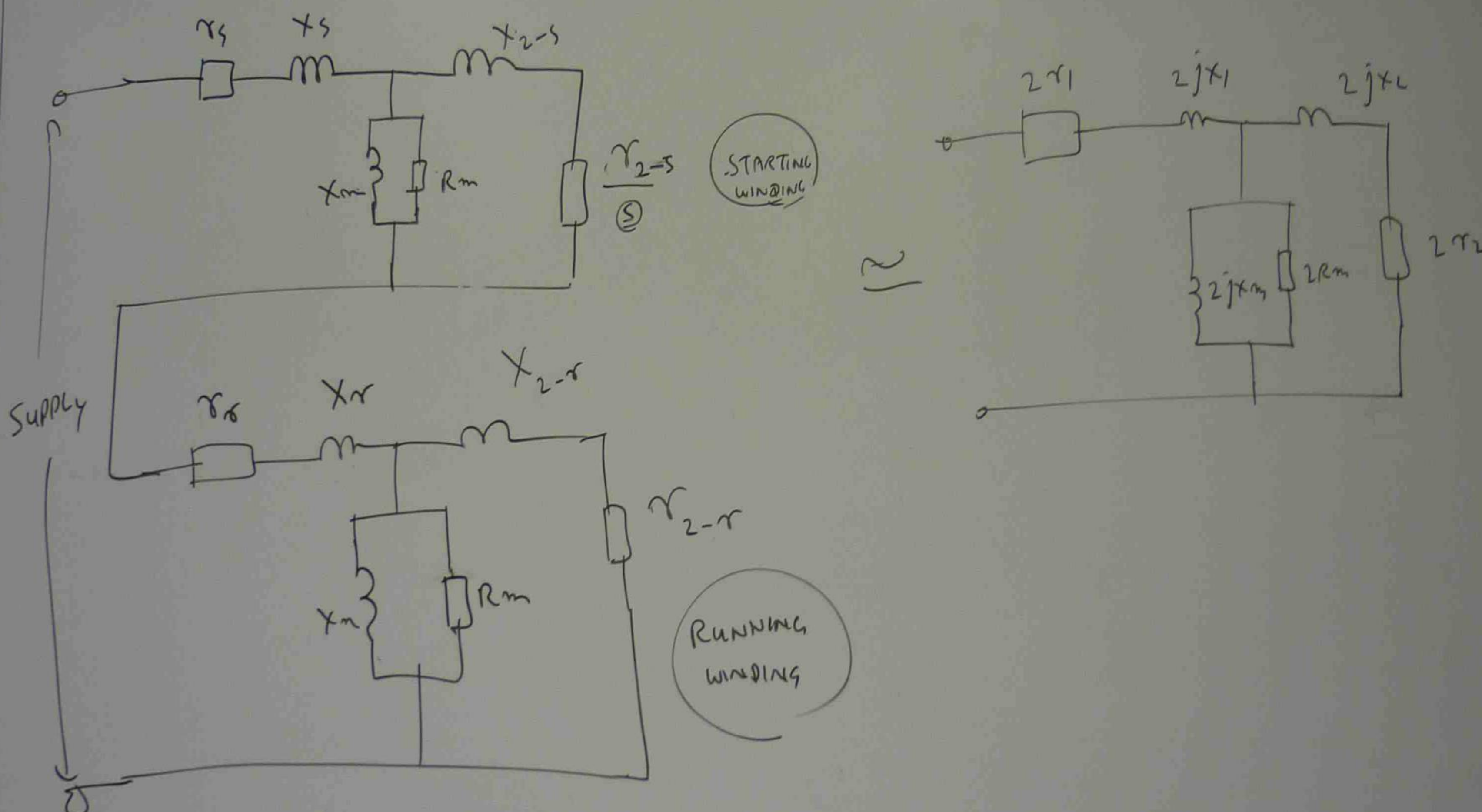
TORQUE REQUIRED TO LOCK THE ROTOR

BREAK DOWN TORQUE

TORQUE THAT STALLS THE MOTOR

$$\text{LOCKED ROTOR AMPERE} = \frac{1000 \times HP \times kVA/HP}{1.73 \times \text{VOLT}}$$

EQUIVALENT CIRCUIT of 1φ motor



Pb A SMALL 60 HZ HYSTERESIS CLOCK MOTOR POSSESSES 32 poles. IN MAKING ONE TURN, HYSTERESIS LOSS IN ROTOR IS 0.8 J

FIND (a) PULL IN & PULL OUT TORQUE

(b) MAXIMUM POWER OUTPUT BEFORE MOTOR STALLS

(c) ROTOR LOSSES WHEN THE MOTOR STALLS

(d) ROTOR LOSSES WHEN THE MOTOR RUNS AT SYNCHRONOUS SPEED.

(a) $T_{\text{pull in, pull out}} = \frac{\text{ENERGY}}{6.28} = \frac{0.8\text{ J}}{6.28} = 0.127$ N-m

(b) $\underset{\text{RPM}}{n} = \frac{120f}{P} = \frac{120 \times 60}{32} = 225$ RPM

$$P_{MAX} = \frac{nT}{9.55} = \frac{225 \times 0.127}{9.55} = 3\text{W}$$

(c)

ROTOR LOSSES AT STALL = RPM × ENERGY

= 225 × 0.8 = 180 J

$$\text{POWER} = \frac{\text{LOSSES (ENERGY)}}{60}$$

$$= \frac{180}{60} = 3\text{W}$$

(d) NO ENERGY LOSSES