BAE701 Engineering Fundamentals

Electrical

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Then study **Section 4-Electrical Engineering (PDF File Page 885)**
For every topic, you need to write the short note on what you understand, formula, summary, outlines and at least 2 problems solution (Please note, each problem is solved in short form, you need to clearly reproduce them by step by step)

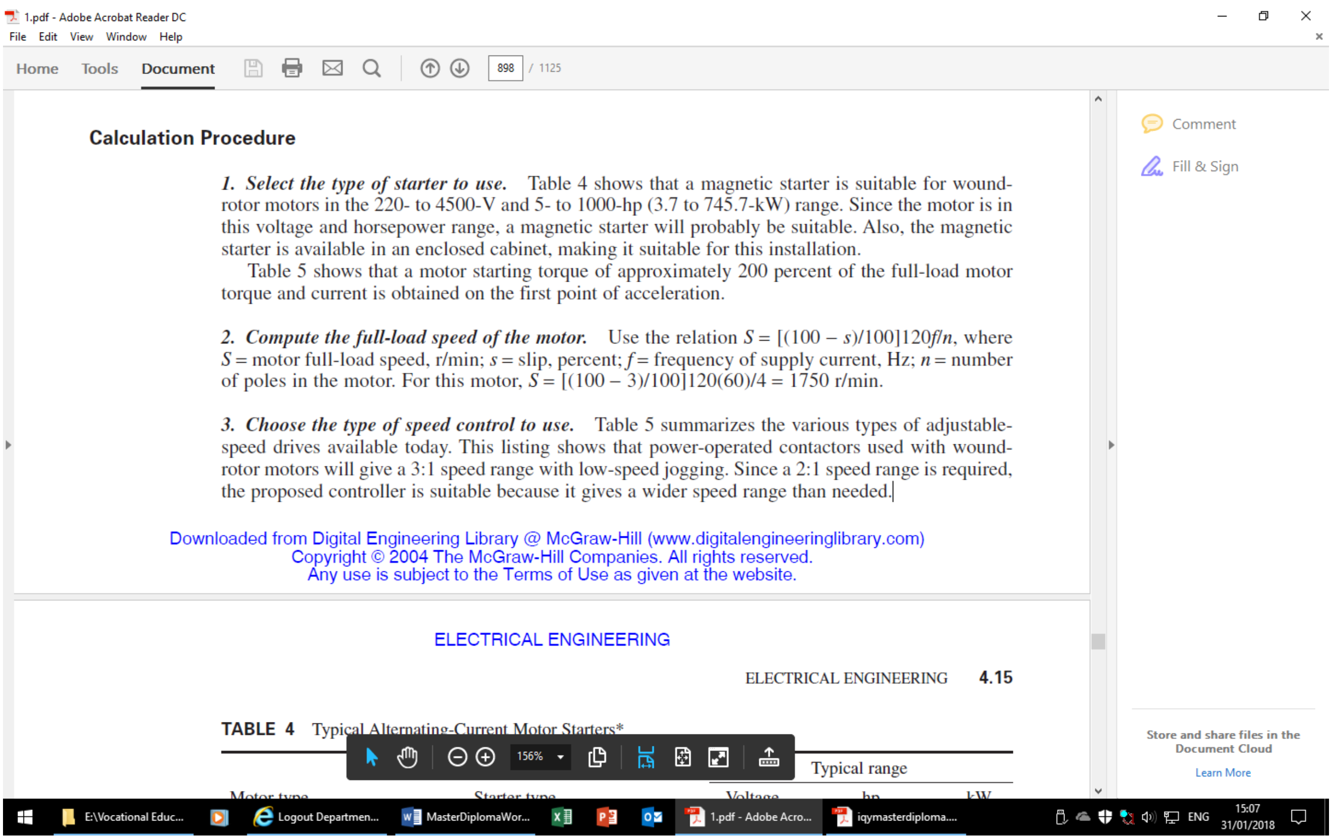
This is my worked example for Selecting Electric-Motor Starting and Speed Controls Sections ,

SELECTING ELECTRIC-MOTOR STARTING AND SPEED CONTROLS

Problem

Choose a suitable starter and speed control for a 500-hp (372.8-kW) wound-rotor ac motor that mus thave a speed range of 2 to 1 with a capability for low-speed jogging. The motor is to operate at about 1800 r/min with current supplied at 4160 V, 60 Hz. An enclosed starter and a controller are desirable from the standpoint of protection. What is the actual motor speed if the motor has four poles and a slip of 3 percent?

Outlined Solution



Calculation Procedure

1. ***Select the type of starter to use.*** Table 4 shows that a magnetic starter is suitable for wound-rotor motors in the 220- to 4500-V and 5- to 1000-hp (3.7 to 745.7-kW) range. Since the motor is in this voltage and horsepower range, a magnetic starter will probably be suitable. Also, the magnetic starter is available in an enclosed cabinet, making it suitable for this installation.
Table 5 shows that a motor starting torque of approximately 200 percent of the full-load motor torque and current is obtained on the first point of acceleration.

2. ***Compute the full-load speed of the motor.*** Use the relation $S = [(100 - s)/100]120f/n$, where S = motor full-load speed, r/min; s = slip, percent; f = frequency of supply current, Hz; n = number of poles in the motor. For this motor, $S = [(100 - 3)/100]120(60)/4 = 1750$ r/min.

3. ***Choose the type of speed control to use.*** Table 5 summarizes the various types of adjustable-speed drives available today. This listing shows that power-operated contactors used with wound-rotor motors will give a 3:1 speed range with low-speed jogging. Since a 2:1 speed range is required, the proposed controller is suitable because it gives a wider speed range than needed.

TABLE 4 Typical Alternating-Current Motor Starters*

Typical range

TABLE 4 Typical Alternating-Current Motor Starters*

Motor type	Starter type	Typical range		
		Voltage	hp	kW
Squirrel cage	Magnetic, full voltage	110–550	1.5–600	1.1–447
	With fusible or nonfusible disconnect or circuit breaker	208–550	2–200	1.5–149
	Reversible	110–550	1.5–200	1.1–149
	Manual, full voltage	110–550	1.5–7.5	1.1–5.6
	Manual, reduced voltage, autotransformer	220–2500	5–150	3.7–112
	Magnetic, reduced voltage, autotransformer	220–5000	5–1750	3.7–1305
	Magnetic, reduced voltage, resistor	220–550	5–600	3.7–447
Wound rotor	Magnetic, primary and secondary control	220–4500	5–1000	3.7–746
	Drums and resistors for secondary control	1000 max	5–750	3.7–559
Synchronous	Reduced voltage, magnetic	220–5000	25–3000	19–2237
	Reduced voltage, semimagnetic	220–2500	20–175	15–131
	Full voltage, magnetic	220–5000	25–3000	19–2237
High-capacity induction	Magnetic, full voltage	2300–4600	To 2250	To 1678
	Magnetic, reduced voltage	2300–4600	To 2250	To 1678
High-capacity synchronous	Magnetic, full voltage	2300–4600	To 2500	To 1864
	Magnetic, reduced voltage	2300–4600	To 2500	To 1864
High-capacity wound rotor	Magnetic, primary and secondary	2300–4600	To 2250	To 1678

*Based on Allis-Chalmers, General Electric, and Westinghouse units.

Refer table 4,

Wound rotor motor – magnetic, primary and secondary control

Drums and resistors for secondary control

for wound rotor motors in 220 → 4500V

5 to 1000 HP (3.7 to 745.7 kW)

As this motor is in this voltage and horse power range, a magnetic starter is suitable

<u>motor full load speed</u>

$$S = \left[\frac{(100 - ⓢ)}{100}\right] \times \frac{120f}{n}$$

S = motor full load speed r/min

ⓢ = slip (%)

f = frequency of supply current (Hz)

n = number of poles in motor

$$S = \frac{(100-3)}{100} \times \frac{120 \times 60}{4} = 1750 \text{ r/min}$$

TABLE 5 Adjustable-Speed Drives

Drive features	Drive types: Constant-voltage dc	Adjust.-voltage dc motor-generator set	Adjust.-voltage rectifier	Eddy-current clutch	Wound-rotor ac, standard	Wound-rotor thyratron	Wound-rotor dc-motor set
Power units required	Rectifier, dc motor	Ac motor, dc generator, dc motor	Rectifier, reactor,[a] dc motor	Ac motor, eddy-current clutch	Ac motor	Ac motor, thyratrons	Ac motor, dc motor, rectifier
Normal speed range	4:1	8:1 c-t +[b] 4:1 c-hp[c]	8:1 c-t + 4:1 c-hp[c]	34:1, 2 pole; 17:1, 4 pole	3:1	10:1[c]	3:1
Low speed for jogging	No[d]	Yes	Yes	Yes	Yes	Yes	Yes
Torque available	c-hp	c-t	c-t	c-t	c-t	c-t	c-t, c-hp
Speed regulation	10–15%	5% with regulator	5% with regulator	2% with regulator	Poor	±3%	5–7½%
Speed control	Field rheostat	Rheostats or pots	Rheostats or pots	Rheostats or pots	Steps, power contactors	Rheostats or pots	Rheostats or pots
Enclosures available	All	All	All	Open[e]	All	All	All
Braking:							
Regen	No	Yes	No	No	Yes	Yes	No
Dynamic	Yes	Yes	Yes	No[f]	Yes	Yes	Yes
Multiple operation	Yes	Yes	Yes	Yes	Yes	Yes	No
Parallel operation	Yes	Yes	Yes	Yes	No	Yes	Yes
Controlled acceleration, deceleration	Yes	Yes	Yes	Yes	No	Yes	No

Drive features	Constant-voltage dc	Adjust.-voltage dc motor-generator set	Adjust.-voltage rectifier	Eddy-current clutch	Wound-rotor ac, standard	Wound-rotor thyratron	Wound-rotor dc-motor set
		regulator	regulator	regulator			
Speed control	Field rheostat	Rheostats or pots	Rheostats or pots	Rheostats or pots	Steps, power contactors	Rheostats or pots	Rheostats or pots
Enclosures available	All	All	All	Open[e]	All	All	All
Braking:							
Regen	No	Yes	No	No	Yes	Yes	No
Dynamic	Yes	Yes	Yes	No[f]	Yes	Yes	Yes
Multiple operation	Yes	Yes	Yes	Yes	Yes	Yes	No
Parallel operation	Yes	Yes	Yes	Yes	No	Yes	Yes
Controlled acceleration, deceleration	Yes	Yes	Yes	Yes	No	Yes	No

Drive features	Constant-voltage dc	Adjust.-voltage dc motor-generator set	Adjust.-voltage rectifier	Eddy-current clutch	Wound-rotor ac, standard	Wound-rotor thyratron	Wound-rotor dc-motor set
Efficiency	80–85%	63–73%	70–80%	80–85%	80–85%	80–85%	80–85%
Top speed at maximum torque	83–87%	60–67%	60–70%	29%	29%	85–90%	73–78%
Rotor inertia[g]	100%[h]	100%	100%	75%	90%	90%	175%
Starting torque	200–300%	200–300%	200–300%	200–300%	200%	200–300%	200–300%
Number of comm. rings	1 comm.	2 comm.	1 comm.	None	1 set rings	1 set rings	1 comm., 1 set rings

[a]Used only in saturable-reactor designs.
[b]c-t—constant-torque; c-hp—constant horsepower.
[c]Units of 200:1 speed range are available.
[d]Low speed can be obtained by using armature resistance.
[e]Totally enclosed units must be water- or oil-cooled.
[f]Eddy-current brake may be integral with unit.
[g]Based on standard dc motor.
[h]Normally is a larger dc motor since is has slower base speed.

2. *Compute the short-circuit current with the small transformer.* With a short circuit at *F*, the only impedance limiting the short-circuit current flow is the transformer impedance of 0.2 Ω

Type of speed control, Refer Table 5

wound rotor ac motor

Normal speed range 3:1

Low speed for jogging Yes

speed control step/power contactor

as 2:1 speed range is required, we can choose

power contactor

Note from Table 5 that if a wider speed range were required, a thyratron control could produce a range up to 10:1 on a wound-rotor motor. Also, a wound-rotor dc motor set might be used too.

In such an arrangement, an ac and dc motor are combined on the same shaft. The rotor current is converted to dc by external silicon rectifiers and fed back to the dc armature through the commutator.

Related Calculations Use the two tables presented here to guide the selection of starters and controls for ac motors serving industrial, commercial, marine, portable, and residential applications.

To choose a dc motor starter, use Table 6 as a guide.

Speed controls for dc motors can be chosen by using Table 7 as a guide. Dc motors are finding increasing use in industry. They are also popular in marine service.

TABLE 6 Direct-Current Motor Starters

Type of starter	Typical uses
Across-the-line	Limited to motors of less than 2 hp (1.5 kW)
Reduced voltage, manual control (face-plate type)	Used for motors up to 50 hp (37.3 kW) where starting is infrequent
Reduced voltage, multiple switch	Motors of more than 50 hp (37.3 kW)
Reduced voltage, drum switch	Large motors; frequent starting and stopping
Reduce voltage, magnetic switch	Frequent starting and stopping; large motors

3. Compute the short-circuit current with the large transformer. Use the same relation as in step 2. Or, $I_S = 440/0.02 = 22{,}000$ A. Thus, the larger transformer, installed to handle the greater load, will require a circuit breaker with a much higher rating. Note that the motor-load current will remain the same, yet the short-circuit current increases tenfold as the system load increases.

Related Calculations This simple short-circuit computation shows the basic procedure to use. As a circuit and its components become more complex, so do the short-circuit computations. Typical methods are shown in the following calculation procedure.

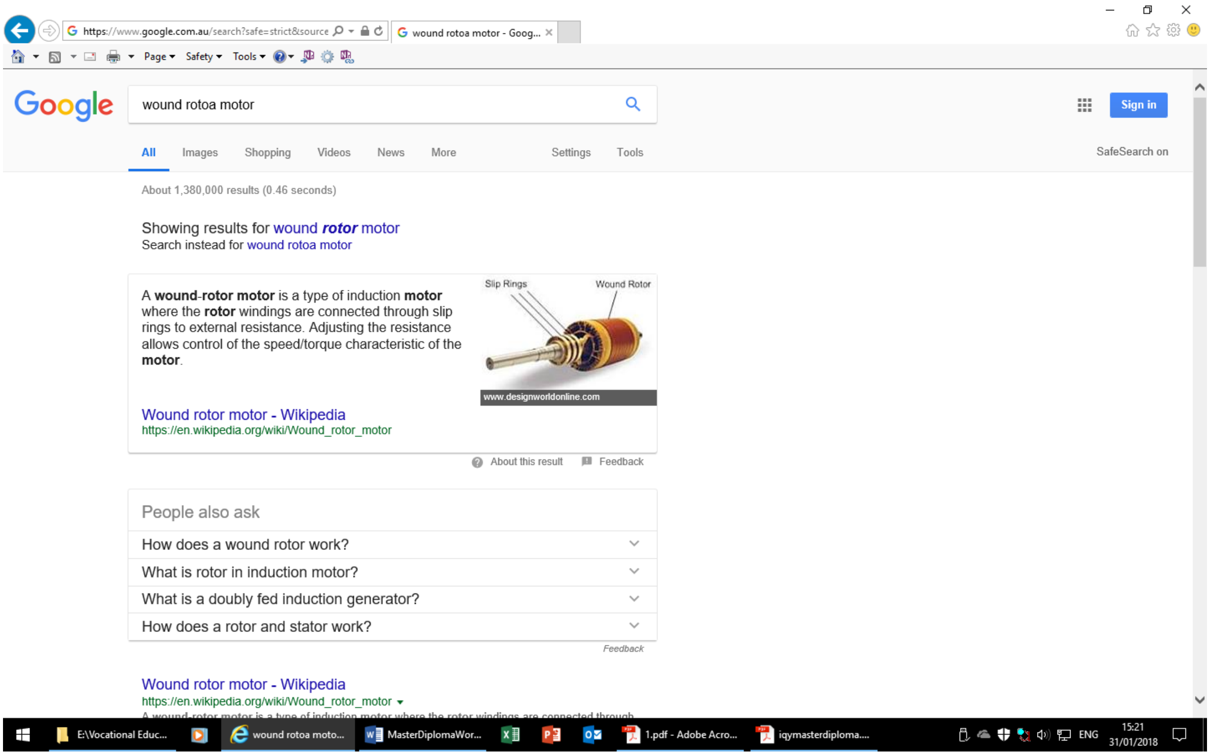
Line *xz*	80,000	13.8	0.65
Line *yz*	85,000	13.8	0.40
Line *z* to short	150,000	13.8	0.45

TABLE 7 Direct-Current Motor-Speed Controls

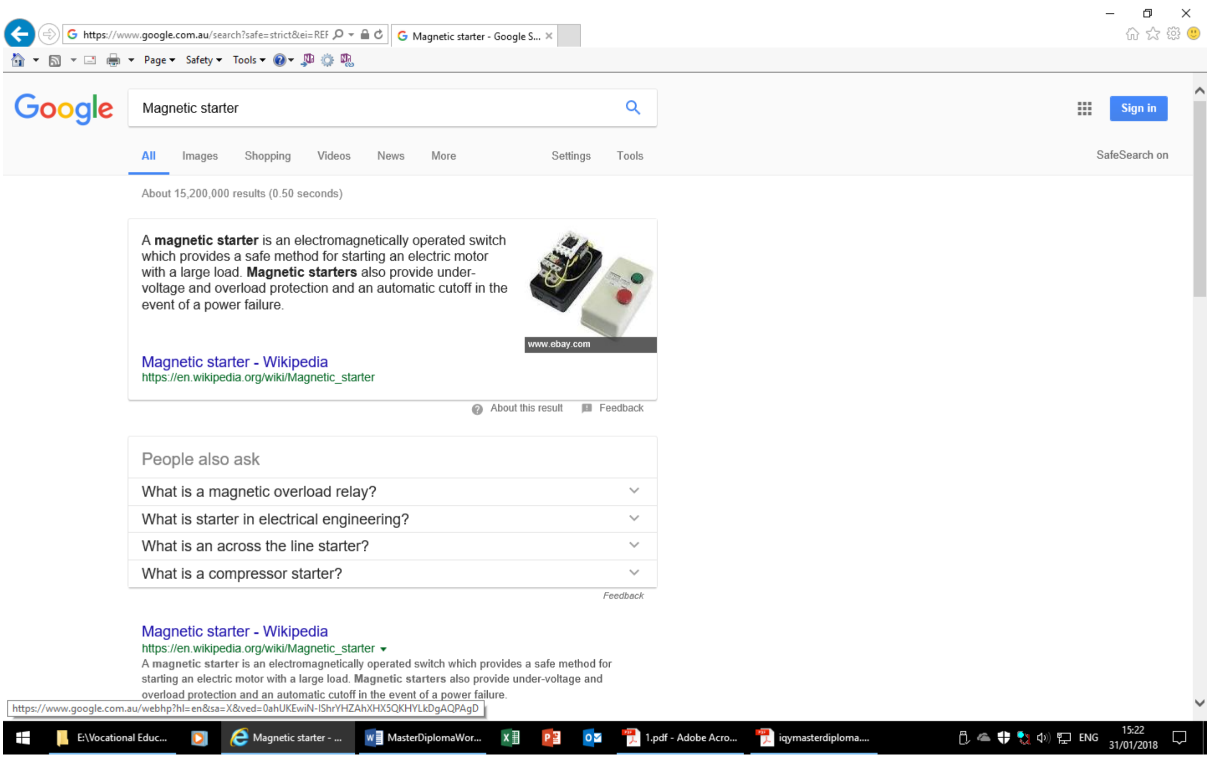
Type of motor	Speed characteristic	Type of control
Series-wound	Varying; wide-speed regulation	Armature shunt and series resistors
Shunt-wound	Constant at selected speed	Armature shunt and series resistors; field weakening; variable armature voltage
Compound-wound	Regulation about 25 percent	Armature shunt and series resistors; field weakening; variable armature voltage

TECHNICAL TERMS

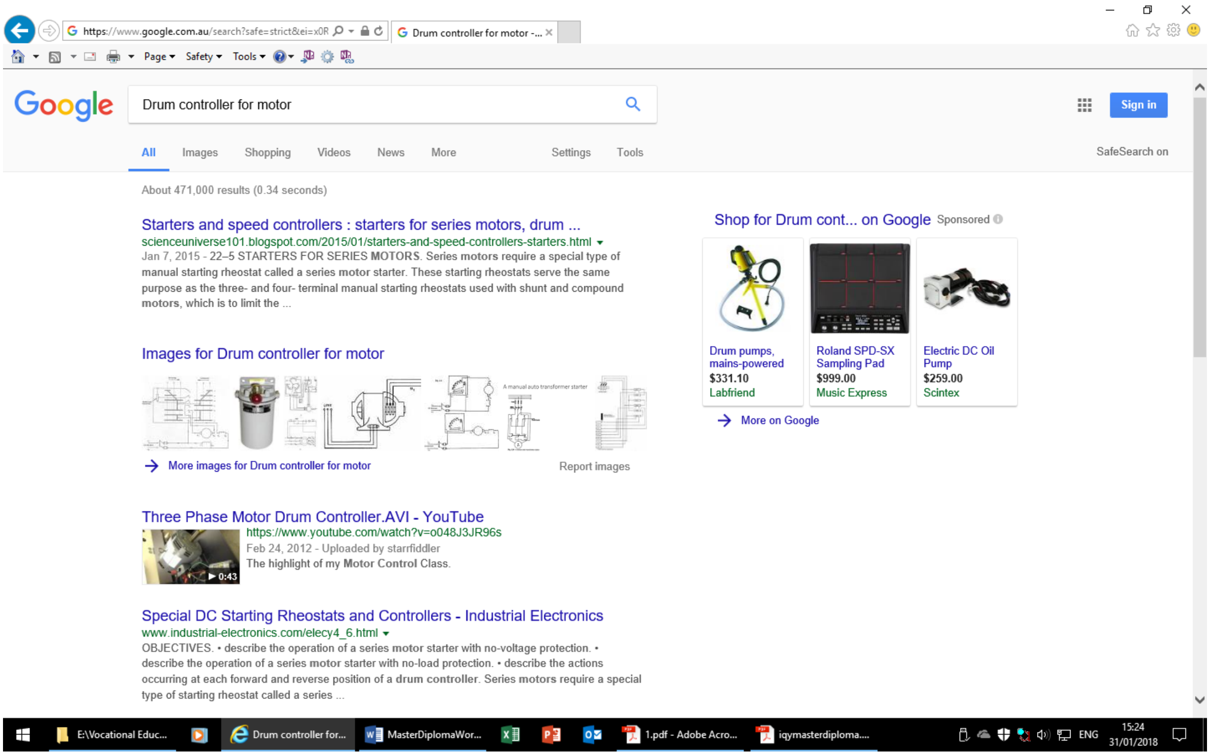
Wound rotor motor?   , Do internet search



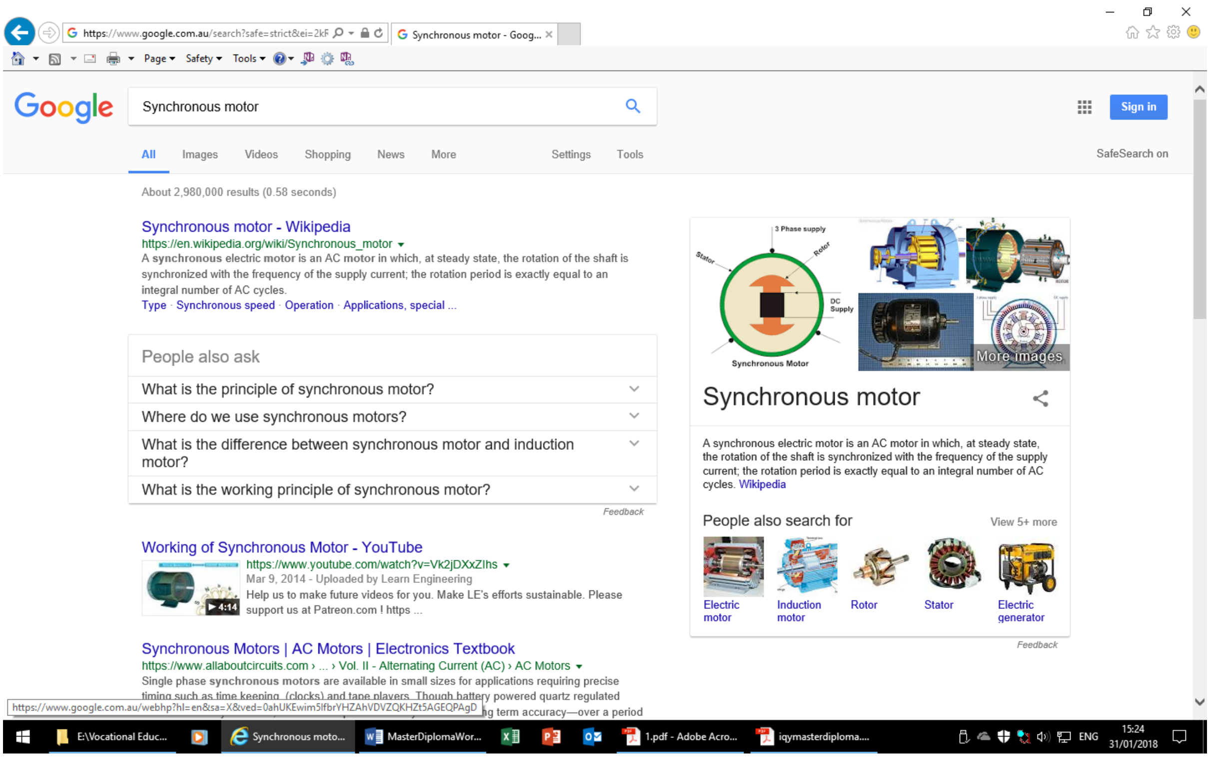
Magnetic starter, Do internet search



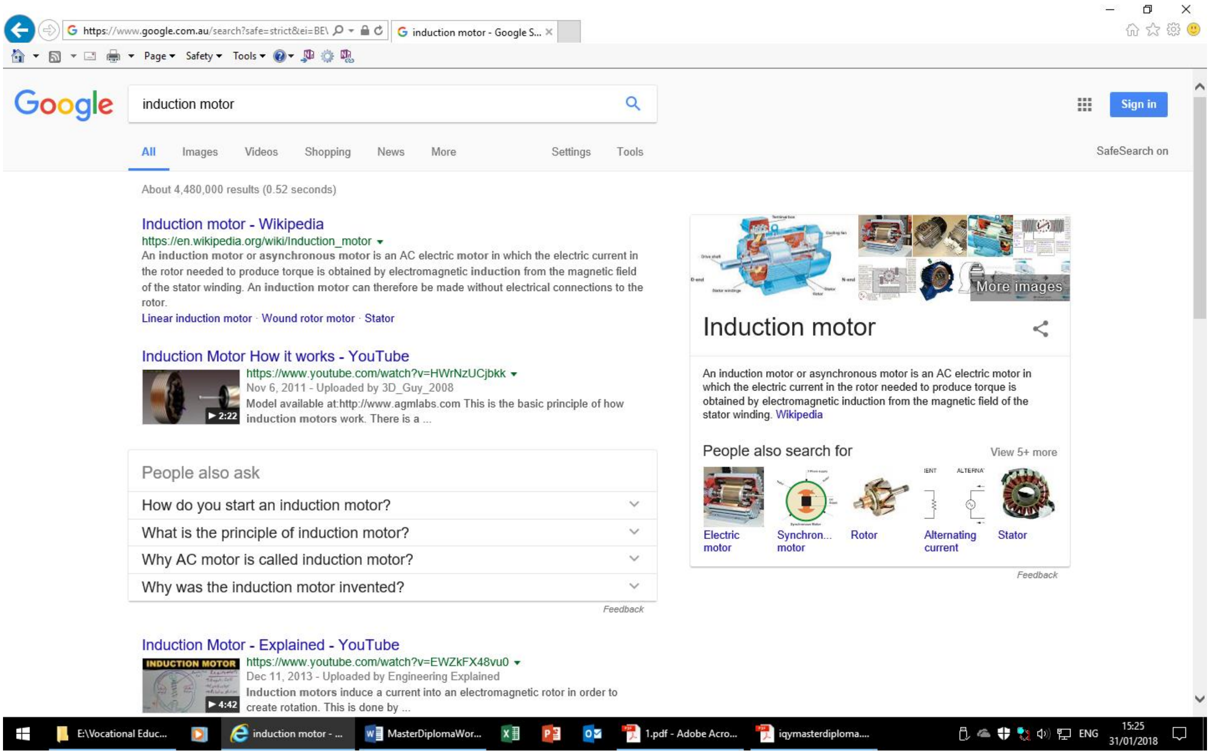
Drum control, do Internet search



Synchronous motor, Do internet search



Induction motor, do internet search



For every topic, you need to write the short note on what you understand, formula, summary, outlines and at least 1problems solution (Please note, each problem is solved in short form, you need to clearly reproduce them by step by step)

It means that , from

Direct-Current Circuit Analysis , you prepare the detailed solution like as my worked example for two problems

Kirchhoff's Laws for DC Circuit Analysis, you prepare the detailed solution like as my worked example for two problems

BAE708 Engineering Knowledge

Electrical

http://www.highlightcomputer.com/MasterofEngineeringElectricalCourseWorkGraduateDiplomaSyllabus.pdf

From the list of the subject, select two subjects, ask me to send the e-Book. Then you have to do the followings

The students will have to write 20 pages study report for each of the subjects outlined below.
The report needs to include

Book review- Review on each chapter of the book highlighting the key concepts, key formula, key theory & practical application concepts

Own idea on how to apply those concepts in real practical applications.
Examples of engineering designs that use the concepts & knowledge expressed in those books (If any)

Your comment on each book

BAE708 will be completed when you have done the above tasks

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Worked Example

BAE 670-Power System Engineering

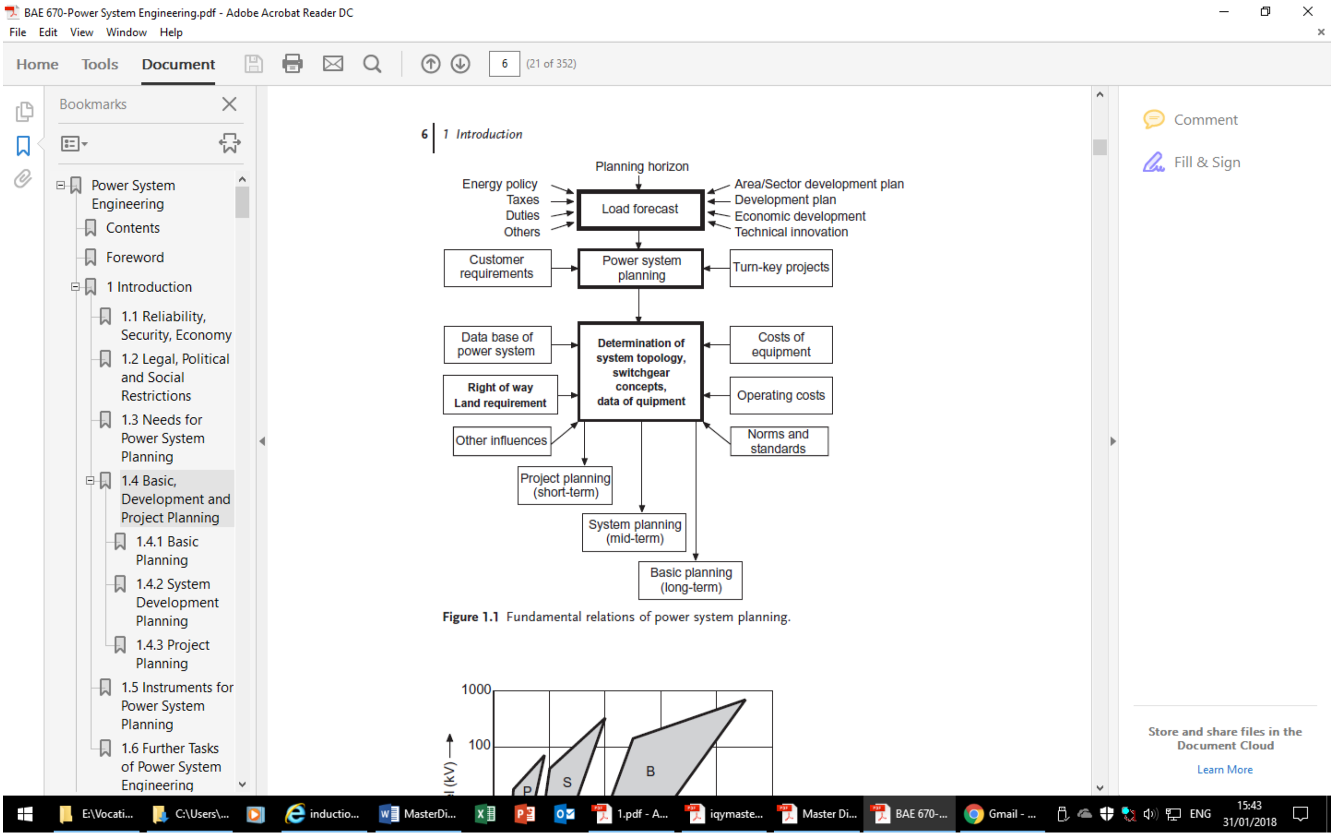
Chapter 1.4 Basic, Development and Project Planning

Book review- Review on each chapter of the book highlighting the key concepts, key formula, key theory & practical application concepts

Key concepts

Load forecast, power system planning and project engineering are assigned to special time intervals, defining partially the tasks to be carried out. Generally three steps of planning are to be considered – basic planning, development planning and project planning

Key Formula / If the process is described by diagram, you can use it



Key Theory

Basic Planning

For all voltage levels the fundamental system concepts are defined: standardization of equipment, neutral earthing concepts, nominal voltages and basics of power system operation. The planning horizon is up to 10 years in low - voltage systems and can exceed 20 years in high - voltage transmission systems.

System Development Planning

Detailed planning of the system topology is carried out based on the load forecast. Alternative concepts are analyzed technically by load - flow calculations,

Project Planning

The projects defined in the system development planning stage are implemented. Typical tasks of the project engineering are the connection types of new customers, connection of new substations to the power system, restructuring measures, evaluation of information on system loading, preparation of tender documents and evaluation of offers, supervising construction contracts, cost calculation and cost control. Project planning covers a time range of one year in the low - voltage system and up to four years in the high - voltage system

Practical Applications

The load- flow analysis (also named power - flow calculation) is a fundamental task for planning and operation of power systems. It serves primarily to determine the loading and the utilization of the equipment, to calculate the active and reactive power - flow in the branches (lines, transformers, etc.) of the power system, to determine the voltage profile and to calculate the power system losses. Single or multiple outages of equipment can be simulated in the context of the investigations for different preloading conditions. The required setting range of the transformer tap - changer and the reactive power supply by generators or compensation devices are determined.

Short - circuit current calculations are carried out for selected system configurations, defined by load - flow analysis. For special applications, such as protection coordination, short - circuit current calculation should consider the preloading conditions as well. Symmetrical and unsymmetrical faults are simulated and the results are taken as a basis for the assessment of the short - circuit strength.

Calculations of short - circuit current for faults between two systems are sometimes necessary to clarify system disturbances. Faults between two systems may occur in cases of multiple - circuit towers in overhead - line systems

The permissible thermal loading of equipment under steady - state conditions and under emergency conditions is based on ambient conditions, for example, ambient temperature, thermal resistance of soil, wind velocity, sun exposure and so on.

The investigation of the static and in particular transient stability is a typical task when planning and analyzing high - voltage transmission systems. Stability analysis is also important for the connection of industrial plants with their own generation to the public supply system. Stability analysis has to be carried out for the determination of frequency - and voltage - dependent load - shedding schemes

In industrial power systems and auxiliary supply systems of power stations, both of which are characterized by a high portion of motor load , the motors must start again after short - circuits or change - overs with no - voltage conditions. Suitable measures, such as increase of the short - circuit power and time - dependent control of the motor starts, are likewise tasks that are carried out by stability analyses.

The insulation of equipment must withstand the foreseeable normal voltage stress.

Your comment

This chapter outlines the general aspects of power system planning regarding load flow, system stability, system faults, natures of installed loads, system equipment etc.

Furthermore it draws the wider view on Harmonic distortion, equipment installation, electromagnetic field, earthing neutral, economy, losses evaluation and protection scheme.

It is my example for Chapter 1.4 Basic, Development and Project Planning, you need to do the similar study notes for the rest of chapters if you choose to do the study report on.

If you choose to do the study report on other books/ subjects, you need to follow the same way.

For BAE702 to 707, just follow the study instructions and submit the assignments

For Masters part 2, design, if you are working, you can submit your workplace design work. If you are not working at the site, you need to find one engineering topic, collect the reference resources, internet search and write a paper.

Reference

www.iqytechnicalcollege.com/MasterDiplomaWorkExamplesElectrical.pdf

http://www.iqytechnicalcollege.com/BAE 670-Power System Engineering.pdf