FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY

SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME: BACHELOR OF ENGINEERING (ELECTRICAL & RENEWABLE)
YEAR 3 (BENG 3)

EEE784 POWER GENERATION

FINAL EXAMINATION

SEMESTER 1, 2016

TOTAL MARKS: 100
No. of Pages: 6

Duration: 3 hours

DATE/TIME/ROOM – Refer to Timetable

INSTRUCTIONS TO CANDIDATES

1. You are allowed 10 minutes extra time during which you are not to write.
2. Begin each answer on a fresh new page and use both sides of the sheets.
3. Write your identification number on the top of each attached sheet.
4. Insert all written foolscaps, graph paper, drawing paper etc. in their correct sequence and secure with string provided.
5. For all sheets of paper in which has been done, cross it through and you must attach to your answer script.
6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.
7. *There are Five (5) sections, **ALL SECTIONS ARE COMPULSORY.***

SECTION A Short Answer Questions [15 Marks]

1. Define the term "**Distributed Generation**". **[1 mark]**

2. Differentiate between a "**Prime load**" and a "**Base load**" generator. **[1 mark]**

3. Explain the following systems of a "**Diesel Power Plant**".

   i) Cooling System
   ii) Lubrication system **[2 marks]**

4. Explicate the term "**synchronizing**" and state any 3 requirements of it. **[2 marks]**

5. Discuss the functions of a "**Governor**" and a "**Prime-mover**". **[2 marks]**

6. Discuss components and operation of a **Hydro Power Plant**. **[2 marks]**
   [2 marks]

7. Explain the term "**Power Factor**". **[1 mark]**

8. Elaborate on the term "**spinning reserves**" and explain the essence of it. **[1 mark]**

9. Define: "**demand factor**" and "**plant capacity factor**". **[1 mark]**

SECTION B [25 Marks]

1. Show that P(kW) = 9.81QH for a Hydro Power Plant. **[4 marks]**

2. A Hydroelectric plant is supplied from a catchment area of 600 km^2 with an annual rainfall of 1400 mm and head of 350 m. Consider a yield factor of 50% and load factor of 60 %. Calculate the power produced and the capacity of the power plant if the power plant has an efficiency of 90 %. **[7 marks]**

3. A village in Dreketi requires 10kW of electrical power to cater for their needs. A river, which can provide a gross head of 80m, is considered for a hydro-power source. The frictional losses in the head was found to be 6.25%. A 2 jet pelton wheel is to be utilized. If the efficiency of the turbine and the genset of the proposed power station are 90% and 80% respectively, calculate the following:

   i) What will be the velocity of the water at the jet given the losses? **[2 marks]**
   ii) The required power input at the jets? **[2 marks]**
   iii) What will be the radius of each jet? **[2 marks]**
   iv) What is the TOTAL flow rate of the system? **[2 marks]**

4. A 6 MVA, 50 Hz, 3-phase star connected synchronous generator having a synchronous reactance of 20 % is running at 1500 rpm and is excited to give 11000 V. Calculate the synchronizing power per two mechanical degree of displacement and the corresponding synchronizing torque. **[6 marks]**

SECTION C [20 Marks]

1. Illustrate and explain the schematic diagram of a *"Combined Heat and Power Plant"* (CHP). **[4 marks]**

2. Sketch and describe the operating cycle of a *"Combined Cycle Power Plant"* (CCPP). **[3 marks]**

3. Comment on the functions of the following in a thermal power plant:
   i) Economizer
   ii) Superheater **[3 marks]**

4. Heat engines employ several different cycles to convert heat energy to mechanical energy. Discuss the Rankine cycle and Brayton cycle. Label these as either open or closed cycle engines, and comment on their efficiencies. **[3 marks]**

5. When two generators are connected in parallel and are jointly supplying the demand in a small power system, the load is shared according to the set points of their governors. Suppose in a small power system, two generators A and B rated at 60MW and 120MW respectively supply a load of 110MW. Both generators are fitted with governors having a droop of 4% and a no-load set point of 52Hz

   i) Using trigonometry, find out the load taken by each of the generators (A and B). **[4 marks]**

   ii) Determine the system frequency **[3 marks]**

6. State 3 advantages of using biomass resource for Power Generation. **[3 marks]**

7. Define Tariffs and also name two types of tariffs. **[2 marks]**

SECTION D [40 Marks]

1. A power station has to supply load as follows:

Time (hours)	6-8	8-12	12-16	16-20	20-24	24-6
Load (MW)	20	40	60	20	50	20

i. Draw the load Curve
ii. Draw the load duration curve
iii. Find the size and number of generating units together with the running hours.
iv. Calculate the load factor
v. Calculate the plant capacity factor **[10 marks]**

2. A hydro power plant is to be used as peak load plant at an annual load factor of 30%. The electrical energy obtained during the year is 750×10^5 kWh. Determine the maximum demand. If the plant capacity factor is 24% find reserve capacity of the plant. (Note Reserve capacity = Capacity – Maximum Demand) **[5 marks]**

3. Explain any 4 essential components of a sub-station in detail. **[4 marks]**

4. Elaborate on the importance of CTs and VTs in a Power System. **[2 marks]**

5. A single phase 230V AC Generator delivers a power of 3kW. Calculate the current when:
   a) The power factor is 0.8
   b) The power factor is unity **[4 marks]**

6. The maximum (peak) load on a thermal power plant of 60 MW capacity is 50 MW at an annual load factor of 50%. The loads having maximum demands of 25 MW, 20 MW, 8 MW and, 5 MW are connected to the power station. Determine: (a) Average load on power station (b) Energy generated per year (c) Demand factor (d) Diversity factor. **[5 marks]**

7. Discuss at least 6 typical costs of power generation and further explain depreciation and interest and how are they applicable in the cost of generation. **[3 marks]**

8. Discuss the Earthing Systems and methods used for a Generator and a Transformer in a Power Station and a Substation. **[2 marks]**

9. Explain earthing grids. Draw sketches of the arrangement. What are they, how does it provide effective earthing? **[3 marks]**

10. Why is it necessary to investigate on soil resistivity prior to earthing? **[2 marks]**

THE END