



Indian Institute of Technology Dharwad  
भारतीय प्रौद्योगिकी संस्थान धारवाड़

## EE101 Spring 2021 Exam 1

Instructor: Dr. Abhijit Kshirsagar  
(username@domain.academic)

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Full Name (all caps): \_\_\_\_\_

Roll Number / ID (all caps): \_\_\_\_\_

### Instructions:

1. Modify this text block to add all the instructions.
2. The front page is designed to have just the instructions - questions begin on the next page.
3. Put away all bags, books, notebooks, cellphones, laptops, tablets, smartwatches, etc.
4. Only ONE A4 or letter sized crib sheet for formulae or notes is allowed.
5. Scientific/programmable calculators are allowed.
6. Write your answers clearly and legibly in the space provided.
7. Points will be awarded for correct formulae, intermediate steps and working.
8. Use the provided paper for rough work if needed.
9. If any data are missing, make reasonable assumptions and state the same with justification.
10. This exam booklet has a total of 8 questions on 7 pages.
11. The exam consists of three sections worth 25 points, 25 points and 50 points respectively.
12. Points for each question are indicated in square brackets in the right margin.
13. For multiple choice questions, select the **best option** or **all correct answers**, as appropriate, and write your response in the space below each question, e.g. **A** or **A,B,D**
14. For fill-in-the-blank questions write the answer in the corresponding blank space.

## Section 1: 4 Points

1. This a multiple-choice question with a single answer. Which among the following is the largest integer? [1]

- A. 1
- B. 2
- C. 3
- D. 4

1. \_\_\_\_\_

2. This is a True / False Question. Is two greater than one?: [1]

- A. True
- B. False

2. \_\_\_\_\_

3. Multiple-choice questions can have more than one correct option also. Identify all the positive number from the following: [1]

- A. 1
- B. -1
- C. 2
- D. -2

3. \_\_\_\_\_

4. This is a fill-the-blanks question. Complete the following series: One, three, \_\_\_\_\_ **five** \_\_\_\_\_, seven, \_\_\_\_\_ **nine** \_\_\_\_\_, eleven. [1]

## Section 2: 1 Points

5. These are some examples of numerical problems. A 1kW load runs continuously for one day. Find the total energy drawn in kJ. [1]

**Solution:** Total Energy = Power x time  
= 1kW × 24h  
= 1000W × 24 × 60 × 60sec  
= 86400kJ

### Section 3: 40 Points

6. These are some “long form” questions. A PV Panel is found to have a maximum power point of 34.1V and 9.83A when tested at STC ( $1\text{kW}/\text{m}^2$ ), and has a stated efficiency of 19.6%. Estimate the active area of this panel (i.e. the area of semiconductor that light falls on) in  $\text{m}^2$ .

[10]

**Solution:** At Standard test conditions, the incident radiant energy is  $1\text{kW}/\text{m}^2$ . Assume that the area of the panel is  $A$ . The radiant power falling on this panel, i.e. incident power, is therefore:

$$P_{\text{incident}} = 1\text{kW}/\text{m}^2 * A$$

The output power is just the incident power times the efficiency:

$$P_{\text{output}} = 1\text{kW}/\text{m}^2 * A * \eta$$

Where efficiency  $\eta = (19.6/100)$ .

The maximum output power can be determined from the maximum power point details:  $P_{\text{out}}$

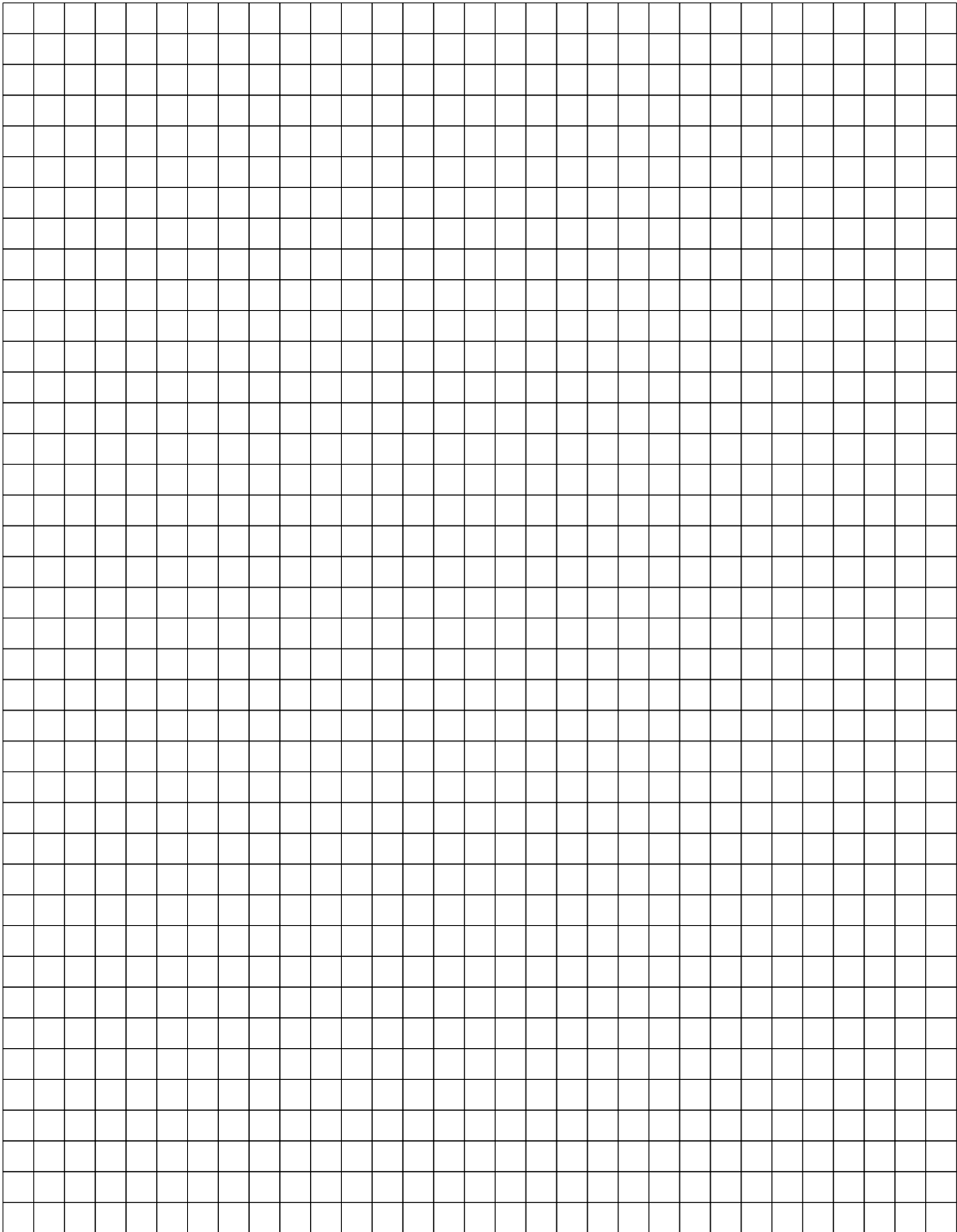
$$P_{\text{out}} = V_{oc} * I_{sc}.$$

Thus, equating the two values of  $P_{\text{out}}$ , we can calculate  $A$ :

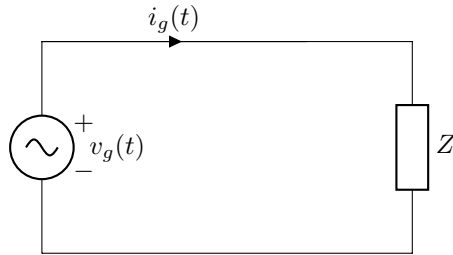
$$A = (V_{oc} * I_{sc}) / (\eta * 1\text{kW}/\text{m}^2) = 1.71\text{m}^2 = 18 \text{ square feet.}$$

7. This is a question that requires a graph / plot as the response. The graph can be generated in  $\text{\TeX}$ . A PV Panel has a maximum power point of 34.1V and 9.83A when tested at STC (standard testing conditions) and a fill factor of 83.8%. The open circuit voltage is found to be 40V. Compute the short circuit current for this panel and then sketch the VI curve, and label the maximum power point.

[10]



8. This is an example of a complex, multi-part question with multiple types of sub-parts. A user wants to connect an inductive load ( $Z$ ) with a rating of 10kW and a power factor of 0.5 to the utility supply, as shown in the figure below. The supply voltage is  $v_g(t) = 170 \sin(\omega t + 0^\circ)$ , with a frequency of 60Hz.



- (a) Calculate values of P, Q and S (with the appropriate units):

[5]

**Solution:** Given that P is 10kW and  $\cos\theta = 0.5$  therefore current lags voltage by  $60^\circ$ .  
 Magnitude of apparent power is therefore  $P/\cos 60^\circ = 20\text{kVA}$ .  
 Therefore  $Q = S \sin \theta = 17.32\text{kVAR}$ .  
 Since the load is inductive, Q has a positive value.

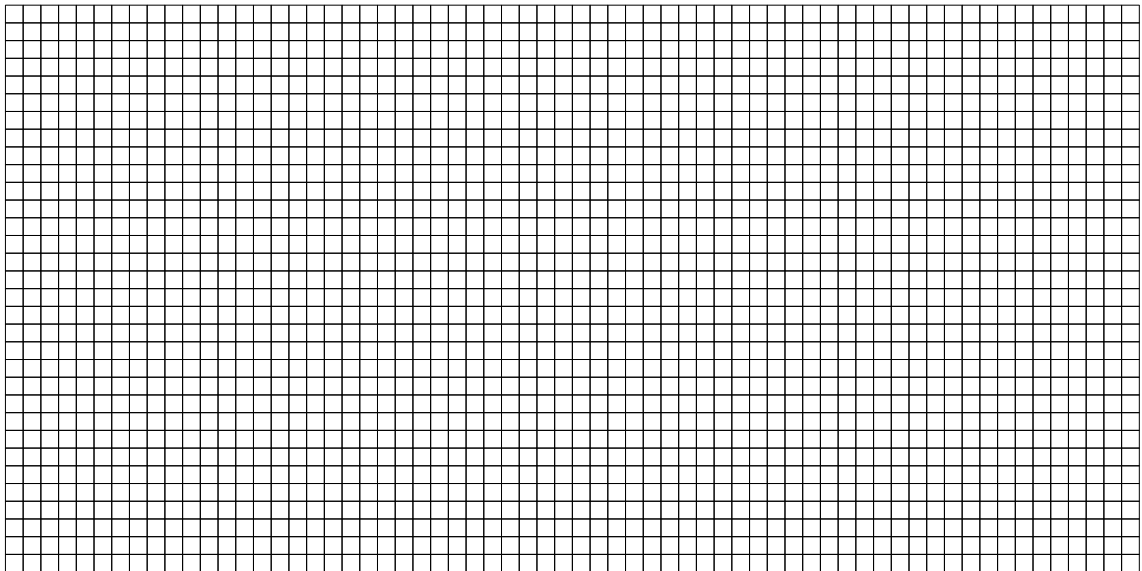
P =           10kW          

Q =           17.32kVAr          

S =           20kVA          

- (b) Draw the power triangle for this load. You can change the spacing of the grid too:

[5]



(c) Calculate the net impedance now.

[5]

**Solution:** The net impedance is the parallel combination of the capacitor's impedance and the existing load. We found that  $Z = 0.181 + 0.313j$ . The impedance of the newly added capacitor is:

$$X_C = \frac{1}{j\omega C} = -0.4171j\Omega$$

Therefore net impedance is:

$$X_C || Z = \frac{ZX_C}{Z + X_C} = 0.7222 - 0.0027j\Omega \approx 0.7222\Omega$$

(d) What is the power factor seen by the grid after the capacitor is installed?

[5]

**Solution:** The power factor is now nearly unity.

Phase angle is about 0.2 degrees which for all practical purposes is almost zero.

**Do not write on this page.**

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Section 1

Question:	1	2	3
Points:	1	1	1
Score:			

Question:	4		Total
Points:	1		4
Score:			

Section 2

Question:	5	Total
Points:	1	1
Score:		

Section 3

Question:	6	7	8	Total
Points:	10	10	20	40
Score:				