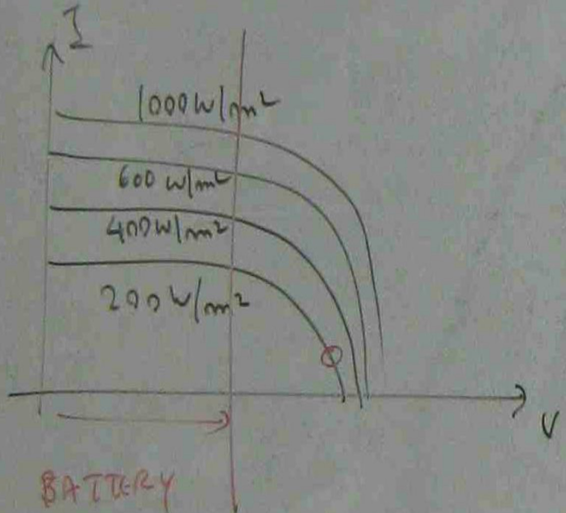
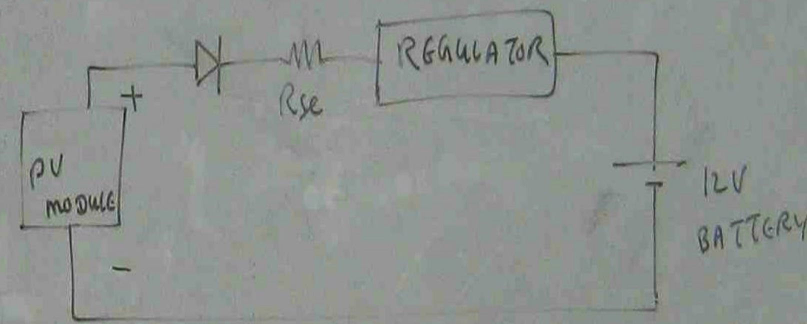
DIRECT BATTERY CHARGING OPERATION



BATTERY CHARGING VOLTAGE (STRAIGHT LINE PORTION)

CALCULATION OF P.V MODULE VOLTAGE TO CHARGE THE BATTERY



P V MODULE VOLTAGE = BATTERY VOLTAGE + REGULATOR & SERIES RESISTANCE VOLTAGE DROP + DIODE VOLTAGE DROP

= 12V (0.5V) (0.7V)

= 12 + 0.5 + 0.7

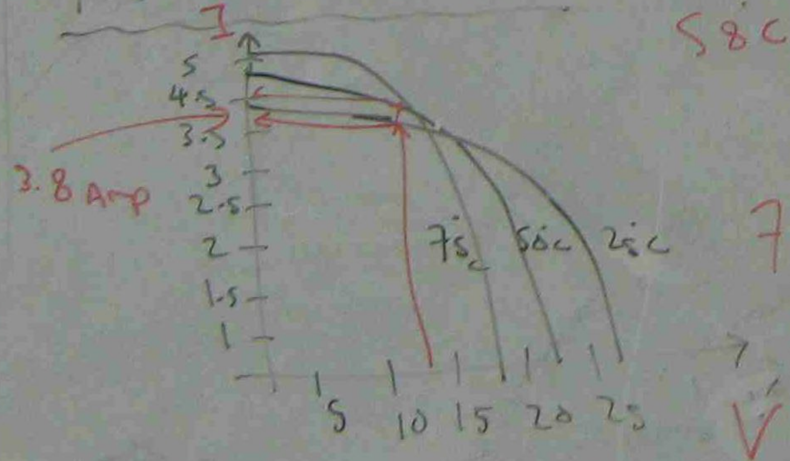
P.V MODULE VOLTAGE = 13.2V

Pb. A BP 585 PV MODULE IS USED TO CHARGE THE 12 V LEAD ACID BATTERY. THE AVERAGE BATTERY VOLTAGE WHILE CHARGING IS 14.5 V. MODULE TEMPERATURE IS 58 °C.

(a) FOR THE CONDITION ABOVE, HOW MUCH CHARGING CURRENT IS THE MODULE PROVIDING?

(b) IF THE MODULE TEMPERATURE IS 72 °C, WHAT CURRENT MUST BE PROVIDED.

I-V CURVE FOR MODULE



58 °C → USE 50 °C LINE

14.5V → 3.8 Amp.

72 °C → USE 75 °C LINE

14.5V → 4.8 Amp.

IRRADIANCE

$$P_G = P_{STC} \times \frac{G}{G_{STC}}$$

P_G = POWER OUT PUT AT ACTUAL IRRADIANCE

P_{STC} = POWER OUT PUT AT STANDARD TEST CONDITION (STC) IRRADIANCE

G = ACTUAL IRRADIANCE

G_{STC} = STANDARD TEST CONDITION IRRADIANCE

$$P_T = P_{STC}\left(1 - \gamma\left(T_{cell} - T_{STC}\right)\right) \times \frac{G}{G_{STC}}$$

pb/ FIND THE OUT PUT OF A MODULE OPERATING AT MAXIMUM POWER POINT GIVING THE FOLLOWINGS THAT

TYPICAL MAXIMUM POWER AT STC = 77 W

NOCT = 49°C

POWER OUT PUT COEFFICIENT = −0.38%/°C

AMBIENT TEMPERATURE = 35°C

IRRADIANCE = 865 W/m²

$P_{STC} = 77\ W \quad \gamma = -0.38\%$

$T_A = 35°C \quad G = 865\ W/m^2$

$\boxed{G_{STC} = 1000\ W/m^2 \quad T_{STC} = 25°C}$

$$P_T = 77\left(1 - 0.38\left(T_{cell} - 25\right)\right) \times \frac{865}{1000}$$

T_{cell} =

=

=

P_T =

f_{dera}

G_{m}

P_{STC}

P_{S}

...ATING AT MAXIMUM POWER

... 77 W

... 8%/°C

... SC

$$\ldots)\Big)\times \frac{865}{1000}$$

$$T_{cell} = T_A + \frac{NOCT - 20}{800} \times G$$

$$= 35 + \frac{49-20}{800} \times 865$$

$$= 66.36$$

$$P_T = 77\Big(1 - 0.38\big(66.36 - 25\big)\Big) \times \frac{865}{1000}$$

$$= 56.1\ W$$

f_{derate} = DERATING FACTOR

E_{module} = DAILY ENERGY OUTPUT OF MODULE

P_{STC} = MODULE POWER OUTPUT RATING UNDER STANDARD TEST CONDITION

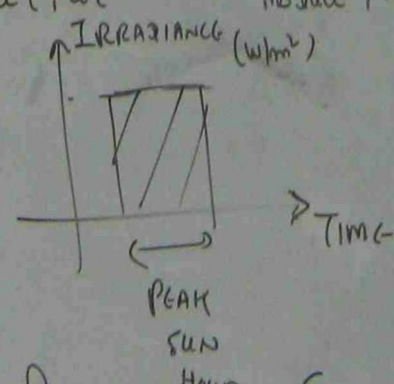
P_{SH} = PEAK SUN HOUR

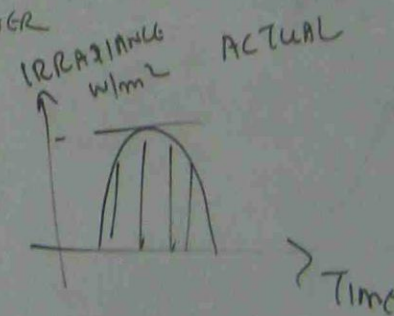
DERATED MODULE POWER OUTPUT IN THE FIELD

THE ACTUAL POWER OUTPUT OF A MODULE AS MEASURED IN THE FIELD. IT MAY ALSO BE REDUCED DUE TO MANUFACTURING TOLERANCE

DAILY ENERGY OUTPUT

DAILY ENERGY OUTPUT = DERATED MODULE POWER × IRRADIATION





$$E_{module} = P_{STC} \times P_{SH} \times f_{derate}$$

pb CRYSTALLINE MODULE, PEAK OUTPUT STC = 80W

IRRADIATION = 22 mJ/m^2 $f_{derate} = 0.75$

CALCULATE DAILY ENERGY OUTPUT

$P_{STC} = 80\,W$ $f_{derate} = 0.75$

$$E_{MODULE} = P_{STC} \times P_{SH} \times f_{derate}$$

$$\boxed{P_{SH} = \frac{\text{IRRADIATION } (mJ/m^2)}{3.8}}$$

$$P_{SH} = \frac{22}{3.8}$$

$$E_{module} = 80 \times \frac{22}{3.8} \times 0.75$$

$$= 367\ \text{w-hr}$$

ACCURATE METHOD FOR BATTERY CHARGING OPERATION

$$E_{module} = V_{module} \times I_{TV} \times f_{man} \times f_{dirt} \times H_{daily}$$

E_{module} = DAILY ENERGY OUTPUT OF THE MODULE

V_{module} = TYPICAL OPERATING VOLTAGE OF THE MODULE ⟷ DEPENDING ON BATTERY CHARGING VOLTAGE

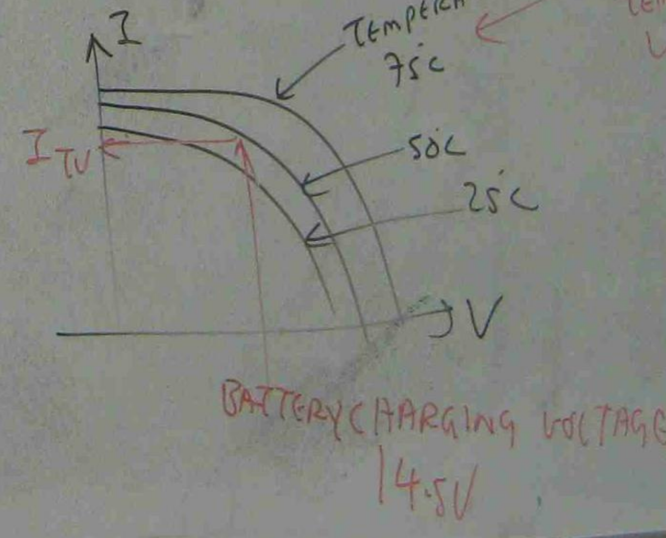
12V BATTERY IS CHARGED AT 14 TO 14.5 V

I_{TV} = OUT PUT CURRENT OF THE MODULE AT THE DAILY AVERAGE CELL OPERATING TEMPERATURE ⟷ CURRENT READ FROM I-V CURVE

f_{man} = DERATING FACTOR FOR MANUFACTURING TOLERANCE

f_{dirt} = DERATING FACTOR FOR DIRT

H_{daily} = DAILY IRRADIATION $\left(kWh/m^2\right)$



SELECT THE TEMPERATURE LINE

$T_{cell\,eff} = T_A + K$

K=

Ho

$T_{cell\,eff}$ = AVERA

CELL