VERY IMPORTANT PROBLEMS 05 (VIP 05-POWER PLANT/MISCELLANEOUS PROBS)

INSTRUCTION: Solve or familiarize the answers of the following very probable problems.

1. Ten kilograms per seconds of steam enter the turbine with an enthalpy of 3200 kJ/kg and enter the condenser with an enthalpy of 2500 kJ/kg in a Rankine cycle. If the turbine efficiency is 80% and the generator efficiency is 90%, determine the power plant output.
   A. 4320 kW C. 4056 kW
   B. 3213 kW D. 5040 kW
   Answer: D
2. The condenser of a reheat power plant rejects heat at the rate of 600 kW. The mass flow rate of cooling water is 5 kg/s and the inlet cooling water temperature is 35°C. Calculate the condenser cooling water exit temperature.
   A. 43.45°C C. 63.66°C
   B. 53.45°C D. 74.34°C
   Answer: C
3. Steam leaves an industrial boiler at 827.4 kPa and 171.6°C. A portion of the steam is passed through a throttling calorimeter and is exhausted to the atmosphere when the calorimeter pressure is 101.4 kPa. How much moisture does the steam leaving the boiler contain if the temperature of the steam at the calorimeter is 115.6°C?At 827.4 kPa (171.6°C)h_f= 727.25 kJ/kgh_{fg}=2043.2 kJ/kg
   From table 3:At 101.4 kPa and 115.6°C h_2= 2707.6 kJ/kg
   A. 3.78% C. 4.56%
   B. 3.08% D. 2.34%
   Answer: B
4. An impulse wheel at best produces 125 hp under a head of 210 ft. By what percent should the speed be increased for a 290-ft head?
   A. 82.5% C. 72.41%
   B. 17.5% D. 27.59%
   Answer: B
5. A logging firm in Isabella operates a Diesel Electric Plant to supply its electric energy requirements. During a 24 hour period, the plant consumed 250 gallons of fuel at 80°F and produced 2900 kW-hrs. Industrial fuel used is 30°API and was purchased at P30.00/li at 60°F. Determine the overall thermal efficiency of the plant.
   A. 26.08% C. 28.00%
   B. 34.23% D. 18.46%
   Answer: C
6. The following coal has the following ultimate analysis by weight: C = 70.5% H_2 = 4.5% O_2 = 6.0%N_2 = 1.0% S = 3.0% Ash = 11%Moisture = 4%
   A stocker fired boiler of 195,000 kg/hr steaming capacity uses this coal as fuel. Calculate volume of air in m^3/hr with air at 60°F and 14.7 psia pressure if boiler efficiency is 70% and FE = 1.10.
   A. 234,019 m^3/hr C. 213,830 m^3/hr
   B. 215,830 m^3/hr D. 264,830 m^3/hr
   Answer: A
7. 23.5 kg of steam per second at 5 MPa and 400°C is produced by a steam generator. The feedwater enters the economizer at 145°C and leaves at 205°C. The steam leaves the boiler drum with a quality of 98%. The unit consumes 3 kg of coal per second as received having a heating value of 25,102 kJ/kg. What would be the overall efficiency of the unit in percent?Steam properties:
   At 5 MPa and 400°C: h = 3195.7 kJ/kg At 5 MPa: h_f = 1154.23, h_{fg} = 1640.1
   At 205°C: h_f = 875.04At 145°C: h_f = 610.63
   A. 65.72 C. 88.28
   B. 80.67 D. 78.82
   Answer: B
8. In a Rankine cycle steam enters the turbines at 2.5 MPa (enthalpies and entropies given) and condenser of 50 kPa (properties given), what is the thermal efficiency of the cycle?At 2.5 MPa: h_g = 2803.1 kJ/kg s_g = 6.2575 At 50 kPa:s_f = 1.0910 s_{fg} = 6.5029 h_f = 340.49 h_{fg} = 2305.4 v_f = 0.0010300
   A. 25.55% C. 34.23%
   B. 45.23% D. 12.34%
   Answer: A
9. A thermal power plant generates 5 MW and the heat generated by fuel is 13,000 kJ/sec. If thermal efficiency is 36.15%, find the power needed for the auxiliaries.
   A. 310 kW C. 400 kW
   B. 300 kW D. 350 kW
   Answer: B
10. A superheat steam Rankine cycle has turbine inlet conditions of 17.5 MPa and 530°C expands in a turbine to 0.007 MPa. The turbine and pump polytropic efficiencies are 0.85 and 0.75 respectively, pressure losses between pump and turbine inlet are 1.5 MPa. What should be the pump work in kJ/kg?
    A. 17.34 C. 25.32
    B. 27.32 D. 47.33
    Answer: C
11. In an open feedwater heater for a steam plant, saturated steam at 7 bar is mixed with subcooled liquid at 7 bar and 25°C. Just enough steam is supplied to ensure that the mixed steam leaving the heater will be saturated liquid at 7 bar when heater efficiency is 95%. Calculate the mass flow rate of subcooled liquid if steam flow rate is 0.865 kg/s.
    Steam properties are:At 7bar, saturated vapor:h_g = 2763.5 kJ/kg
    At 7 bar and 25°C:h_f = 105.5 kJ/kg
    At 7 bar, saturated liquid: h_f= 697.22 kJ/kg
    A. 2.725 kg/s C. 2.869 kg/s
    B. 3.356 kg/s D. 3.948 kg/s
    Answer: C
12. Steam expands adiabatically in a turbine from 2000 kPa, 400°C to 400 kPa, 250°C. What is the effectiveness of the process in percent assuming an atmospheric pressure of 18°C. Neglect changes in kinetic and potential energy.
    Steam properties are:At 2000 kPa and 400°C:h = 3247.6 kJ/kg s = 7.1271 kJ/kg-K At 400 kPa and 250°C:h = 2964.2 kJ/kgs = 7.3789 kJ/kg-K
    A. 82 C. 79.60
    B. 84 D. 79.46
    Answer: D
13. A heat exchanger was installed purposely to cool 0.50 kg of gas per second. Molecular weight is 32 and k = 1.32. The gas is cooled from 150°C to 80°C. Water is available at the rate of 0.30 kg/s and at a temperature of 15°C. Calculate the exit temperature of the water in °C.
    A. 44.86 C. 46.45
    B. 42.86 D. 40.34
    Answer: A
14. A 350 mm x 450 mm steam engine running at 280 rpm has an entrance steam condition of 2 MPa and 230°C and exit at 0.1 MPa. The steam consumption is 2000 kg/hr and mechanical efficiency is 85%. If indicated mean effective pressure is 600 kPa, determine brake thermal efficiency.At 2 MPa and 230°C (Table 3):h_1 = 2849.6 s_1 = 6.4423 At 0.1 MPa:s_f = 1.3026 h_f = 417.46 s_{fg} = 6.0568h_{fg} = 2258h_{f2} = 417.46 kJ/kg
    A. 23.34% C. 14.16%
    B. 15.25% D. 27.34%
    Answer: B
15. A steam turbine receives 5000 kg/hr of steam at 5 MPa and 400°C and velocity of 30 m/sec. It leaves the turbine at 0.006 MPa and 85% quality and velocity of 15 m/sec. Radiation loss is 10,000 kJ/hr. Find the kW developed. At 5 MPa and 400°C: h_1 = 3195.7 kJ/kgs_1 = 6.6459 At 0.006 MPa:h_f = 151.53 h_{fg} = 2415.9
    A. 1273.29 C. 1373.60
    B. 2173.29 D. 7231.29
    Answer: C
16. A steam turbine with 85% stage efficiency receives steam at 7 MPa and 550°C and exhausts as 20 kPa. Determine the turbine work.At 7 MPa and 550°C: h_1 = 3530.9 kJ/kgs_1 = 6.9486 At 20 kPa (0.020 MPa): s_f = 0.8320h_f = 251.40s_{fg} = 7.0766 h_{fg} = 2358.3
    A. 1,117 kJ/kg C.1,123.34 kJ/kg
    B. 1,132 kJ/kg D.1,054.95kJ/kg
    Answer: D
17. A steam turbine with 80% stage efficiency receives steam at 7 MPa and 550°C and exhausts as 20 kPa. Determine the quality at exhaust.At 7 MPa and 550°C: h_1 = 3530.9 kJ/kgs_1 = 6.9486At 20 kPa (0.020 MPa):s_f = 0.8320h_f = 251.40
    A. 96.96% C. 82.34%
    B. 76.34% D. 91.69%
    Answer: A
18. A 18,000 kW geothermal plant has a generator efficiency and turbine efficiency of 90% and 80%,respectively. If the quality after throttling is 20% and each well discharges 400,000 kg/hr,determine the number of wells are required

to produce if the change of enthalpy at entrance and exit of turbine is 500 kJ/kg.
A. 4 wells C. 6 wells
B. 2 wells D. 8 wells
Answer: B

19. A liquid dominated geothermal plant with a single flash separator receives water at 204°C. The separator pressure is 1.04 MPa. A direct contact condenser operates at 0.034 MPa. The turbine has a polytropic efficiency of 0.75. For a cycle output of 60 MW, what is the mass flow rate of the well-water in kg/s?At 204°C: h_f = 870.51 kJ/kg At 1.04 MPa: h_f = 770.38 h_{fg} = 2009.2 h_g = 2779.6 s_g = 6.5729At 0.034 MPa:h_f = 301.40 h_{fg} = 2328.8 s_f = 0.9793 s_{fg} = 6.7463
A. 2,933 C. 1,860
B. 2,100 D. 2,444
Answer: A

20. An engine-generator rated 9000 kVA at 80% power factor, 3 phase, 4160 V has an efficiency of 90%. If overall plant efficiency is 28%, what is the heat generated by the fuel?
A. 18,800 kW C. 7500 kW
B. 28,800 kW D. 25,714 kW
Answer: D

21. The indicated thermal efficiency of a two stroke diesel engine is 60%. If friction power is 15% of heat generated, determine the brake thermal efficiency of the engine.
A. 43% C. 36%
B. 45% D. 37%
Answer: B

22. A 305 mm x 457 mm four stroke single acting diesel engine is rated at 150 kW at 260 rpm. Fuel consumption at rated load is 0.56 kg/kW-hr with a heating value of 43,912 kJ/kg. Calculate brake thermal efficiency.
A. 10.53 % C. 14.64 %
B. 27.45 % D. 18.23 %
Answer: C

23. Ten kilograms per second of steam enter the turbine with an enthalpy of 3200 kJ/kg and enter the condenser with an enthalpy of 2500 kJ/kg in a Rankine cycle. If the turbine efficiency is 80% and the generator efficiency is 90%, determine the power plant output.
A. 4320 kW C. 3213 kW
B. 4056kW D. 5040 Kw
Answer: D

24. The condenser of a reheat power plant rejects heat at the rate of 600 kW. The mass flow rate of cooling water is 5 kg/s and the inlet cooling water temperature is 35 °C. Calculate the condenser cooling water exit temperature.
A. 43.45 °C C. 53.45 °C
B. 63.66 °C D. 74.34 °C
Answer: B

25. A heat engine has a thermal efficiency of 50%. How much power does the engine produce when heat is transferred at a rate of 10^9 kJ/hr?
A. 50 MW C. 75 MW
B. 139 MW D. 147 MW
Answer: B

26. A 3500 KW plant has a utilization factor of 71% and a load factor 39.6%. What is the average load on the plant?
A. 9840.6 KW C. 24850 KW
B. 13860 KW D. 19521.2 KW
Answer: A

27. A 95 MW power plant factor has an average load of 35000 KW and a load factor of 65%. Find the reserve over peak in MW?
A. 21.15 C. 32.41
B. 41.15 D.58.75
Answer: B

28. A power plant is said to have a use factor of 50% and capacity factor of 44%. How many hours did it operated during this year?
A. 6600.32 C. 7708.8
B. 8600.32 D. 5658.23
Answer: C

29. A plant w/ an installed capacity of 30,000 KW has a utilization factor of 83% and a capacity factor of 56%. Find the load factor.
A. 66.47% C. 67.47%
B. 68.47% D. 69.47%
Answer: C

30. An engine has a brake thermal efficiency of 26%, it uses 2 gallons of gasoline per hour. Gas has a heating value of 20500 BTU/Ibm and specific gravity of .80. Find: Power output of engine in KW.
A. 18.85 KW C. 19.85 KW
B. 20.85 KW D. 21.85 KW
Answer: B

31. The heating value supplied in a boiler is 41000 KJ/kg if the factor of evaporation is 10 kg steam /kg fuel. What is the efficiency of the boiler?
A. 60.55% C. 53.08%
B. 78.05% D. 54.97%
Answer: C

32. What is the water rate in kg/hr of an auxiliary boiler which produces steam at .80 MPa and 98% dry from feedwater at 43°C. The fuel calorific value is equivalent to that of 1.2 metric tons/day. Assume an efficiency of 70%
A. 580 C. 615
B. 700 D. 480
Answer: C

33. Two boiler of equal steaming capacity generate steam to a common header of 15MPa pressure. One boiler produces wet steam. If the mixture is saturated steam, find the quality of the steam in the second boiler
@ 1.5 MPa & 250°C h = 2925 KJ/kg
@ 1.5 MPa, h_f = 845 KJ/ kg h_{fg} = 1947 KJ/kg
A. 0.940 C. 0.9317
B. 0.978 D. 0.985
Answer: C

34. Determine power required for 2000 kg car to climb 100m long uphill road with a slope of 30° (from horizontal) in 10 seconds from rest to a final velocity of 30 m/s disregard friction, air drag and rolling resistance
A. 188.066 KW C. 980.66 KW
B. 1880.66 KW D. 900 KW
Answer: A

35. A small steam turbine generator power plant of 5200 MW capacity has a full load steam rate of 6.0 kg/ KW-hr. No load steam consumption may be taken as 10% of full load steam consumption. At 60% load, calculate the hourly steam consumption of this unit.
A. 20,500 kg/hr C. 18,500 kg/hr
B. 25,000 kg/hr D. 19,968 kg/hr
Answer: D

36. The enthalpy of refrigerant is 359 KJ/kg at the compressor entrance and 381 KJ/kg at the compressor exit. The rate of refrigerant flow is 62 kg/min. The heat loss from the compressor is 12% of the work input. Determine the power input in KW.
A. 25.83 C. 20.30
B. 24.65 D. 25.83
Answer: A

37. A six cylinder diesel engine when tested in the lab at 2000 rpm produces a net brake force of 204 N with all its 6 cylinder firing on ly but 163.6 N when on cylinder was cut-off. What is the mechanical efficiency of the diesel engine if the break arm length is .75m
A. 82.5% C. 88.5%
B. 84.14% D. 91%
Answer: B

38. The surface level of water in 92.5m that of a hydraulic turbine. The efficiency (i.e. , the portion of available potential energy the turbine uses) is 90% Determine the volume flow rate water required need to produce 100,000 MW.
A. 117.5 m^3/s C. 122.5 m^3/s
B. 124,.5 m^3/s D. 112,500 m^3/s
Answer: C

39. How many days would an inventory of 1000 bbl of fuel oil with a relative density of 0.90 at an evaporating temperature of 35°C is consumed if used in a 9 MW diesel engine with a full load brake thermal efficiency of 34% at rated load.
A. 3 days C. 2.5 days
B. 1.8 days D. 2 days
Answer: C

40. In a geothermal power plant hot ground water from a hot spring used to power heat engine. If the ground water is at 95°C estimate the max power output if the mass flow rate of ground water is 0.25 kg/s atmosphere is at 20°C
A. 14.0 KW C. 15.0 KW
B. 16 KW D. 12.8 KW
Answer: B

41. A hydraulic turbine which has a diameter of 66 in. a speed of 350 rpm, coefficient of velocity of 0.98, peripheral speed factor of 0.45, generator efficiency of 90% and jet diameter form nozzle of 6 in determine the power input in HP.
    A. 2862 C. 3809
    B. 4933 D. 5366
    Answer: C
42. What is the thermal efficiency of an air standard Brayton cycle if the air enters and leaves the gas turbine at 1000°K and 500°K, respectively?
    A. 40.74% C. 45%
    B. 50.00% D.54.86%
    Answer: B
43. The Philippines is embarking into the use of renewable energy sources like wind power to save on its energy needs. Determine the maximum power in KW that may be derived from a 55 kph wind if the wind rotor to used has a blade diameter of 32 m and the over-all conversion efficiency maybe taken as 35% average air pressure is 100 KPa and ambient temperature of 32°C must be assumed
    A. 573 C. 504
    B. 1050 D. 350
    Answer: A
44. A 500 HP internal combustion engine has a mean effective brake pressure of 551.5 Kpa at full-load. What is the mean effective indicated pressure if the mechanical efficiency of engine is 85%
    A. 468.77 kPa C. 648.823 kPa
    B. 373 kPa D. 588.235 kPa
    Answer: C
45. The enthalpy of ground water in a 19 MW geothermal power plant is 1000 KJ/kg, if the quality after throttling is 28% and overall plant efficiency is 20%. What is the mass flow rate of steam entering the turbine?
    A. 27kg/s C. 76kg/s
    B. 18kg/s D. 34kg/s
    Answer: A
46. Calculate the power that can be developed from a hydro electric power plant having ff.data:
    Catchment's area = 90km^2
    Average annual rain fall = 120cm
    Run-off = 85%
    Available head = 350 m
    Over all Station efficiency = 75%
    A. 8.75 MW C. 6.8 M
    B. 9.99 MW D. 7.5 MW
    Answer: D
47. In a double acting 2 –stroke cycle engine, 8 cylinder, the diameter of the cylinder is 700 mm, and the stroke is 1350 mm and the piston rod diameter is 250 mm. Running at 108 rpm, indicated mean effective pressure above and below the piston are 5.86 and 4.90 Bar respectively, calculate the brake power of the engine in KW if the mechanical efficiency is 80%.
    A. 5060 KW C. 7330 KW
    B. 6030 KW D. 7540 KW
    Answer: B
48. A central power plant, whether the energy source is nuclear or fossil fuel, is a heat engine operating between the temperature of the reactor or furnace and the usually represented by a river or other body of water. Consider a modern nuclear power plant generating 750.000 KW for which the reactor temperature is 586°K and a river is available with a water temperature of 293°K. What is the minimum amount of the heat must be discarded to the river?
    A. 500,000 KW C. 750,000 KW
    B. 1,000,000 KW D. 1,500,000 KW
    Answer: C
49. An automotive engine uses 10.20 L of gas/hr. The density of gasoline is 67 kg/m^3. The engine uses 13.20 kg of air per kg of fuel. Air is supplied at 101 kPa, 30°C. Determine the volume rate of air flow in m^3/ hr, R of air is 287.08 J/kg°K
    A. 6.789 C. 7.769
    B. 8.769 D. 9.769
    Answer: C
50. The power output of a compression ignition engine is 2400 KW when it uses 545 kg of fuel per hour. The higher the heating value of the fuel is 43920 KJ/kg. The frictional power of the engine is 260 KW. Find the indicated thermal efficiency.
    A. 36.1% C. 37.1%
    B. 40% D. 4.5
    Answer: B
51. A waste heat recovery boiler produces 4.8 Mpa (dry saturated) steam from 104°C feedwater. The boiler receives energy from 7 kg/sec of 954°C dry air. After passing through a waste heat boiler, the temperature of the air has been reduce to 343°C. How much steam in kg is produced per second? Note: At 4.80 Mpa dry saturated, h = 2796.
    A. 1.30 C. 1.81
    B. 0.92 D. 3.43
    Answer: C
52. A diesel electric plant supplies energy for Meralco. During a 24-hour period, the plant consumed 240 gallons of fuel at 28°C and produced 3930 KW-hr. Industrial fuel used is 28°API and was purchased at P30 per liter at 15.6°C. What is the cost of fuel be to produce one KW-hr?
    A. P6.87 C. P41.07
    B. P1.10 D. P5.00
    Answer: A
53. In a gas turbine unit, air enters the combustion chamber at 550 kpa, 277°C and 43 m/s. The products of combustion leave the combustor at 511 kpa, 1004°C and 180 m/s. Liquid fuel enters with a heating value of 43,000 KJ/kg. For fuel-air ratio of 0.0229, what is the combustor efficiency of the unit in percent?
    A. 70. 38% C. 75.38%
    B. 79.38% D. 82.38%
    Answer: C
54. The specific speed of turbine is 85 *rpm* and running at 450 rpm. If the head is 20 m and generator efficiency is 90%, what is the maximum power delivered by the generator.
    A. 450.51 KW C. 650.53 KW
    B. 354.52 KW D. 835.57 KW
    Answer: D
55. In Francis turbine, the pressure gage leading to the turbine casing reads 380 Kpa. The velocity of water entering the turbine is 8 m/sec, if net head of the turbine is 45 m, find the distance from center of spiral casing to the tailrace.
    A.3.0 m C.4.0 m
    B.3.5 m D.4.5 m
    Answer: A
56. A turbine has a mechanical efficiency of 93%, volumetric efficiency of 95% and total efficiency of 82%. If effective head is 40 m, find the total head
    A.48.72 m C.40.72 m
    B.36.22 m D. 34.72m
    Answer: B
57. A Pelton type turbine has 25 m head friction loss of 4.5 m. The coefficient of friction head loss(from Morse) is 0.00093 and penstock length of 80 m. What is the penstock diameter?
    A.1,355.73 mm C.6771.23 mm
    B. 3,476.12 mm D.1686.73 mm
    Answer: A
58. In an 9,000 KW hydro-electric plant the over-all efficiency is 88% and the actual power received by the customer is 110,000 KW-hrs for that day. What is the secondary power could this plant deliver during the entire day?
    A.58,960 KW-hrs C.65,960 KW-hrs
    B.80,080 KW-hrs D.70,960 KW-hrs
    Answer: B
59. A Pelton type turbine was installed 30m below the head gate of the penstock. The head loss due to friction is 12 percent of the given elevation. The length of penstock is 100 m and coefficient of friction is 0.00093. Determine the power output in KW. (Use Morse equation)
    A.22,273 C.32,345
    B.23,234 D.34,452
    Answer: D
60. Water flows steadily with a velocity of 3.05 m/s in as horizontal pipe having a diameter of 25.24 cm. At one section of the pipe, the temperature and pressure of the water are 21°C and 689.3 Kpa; respectively. At a distance of 304.8 m downstream, the pressure is 516.9 Kpa. What is the friction factor?
    A. 0.134 C. 0.0307
    B. 0.0050 D. 0.641
    Answer: C
61. A hydro-electric plant having 30 sq. km reservoir area and 100 m head is used to generate power. The energy utilized by the consumers whose load is connected to the power plant during a five-hour period is 13.5 x 10^6 kwh. The

overall generation efficiency is 75%. Find the fall in the height of water in the reservoir after the 5-hour period.
A. 5.13 m C.3.21 m
B. 1.32 m D.2.20 m
Answer: D

62. The gas density of chimney is 0.75 kg/m^3 and air density of 1.15 kg/m^3. Find the driving pressure if the height of chimney is 63.71 m.
A.0.15 kpa C.0.35 kpa
B.0.25 kpa D.0.45 kpa
Answer: B

63. The actual velocity of gas entering in a chimney is 8 m/sec. The gas temperature is 25^{0}C with a gas constant of 0.287 KJ/kg-^{0}K. Determine the gas pressure for a mass of gas is 50,000 kg/hr and chimney diameter of 1.39 m.
A.95 kpa C.101 kpa
B.98 kpa D.92 kpa
Answer: B

64. A steam generator with economizer and air heater has an overall draft loss of 25.78 cm of water. If the stack gases are at 177^{0}C and if the atmosphere is at 101.3 Kpa and 26^{0}C, what theoretical height of stack in meters is needed when no draft fan are used? Assume that the gas constant for the flue gases is the same as that for air.
A. 611.10 C. 651.10
B. 631.10 D. 671.10
Answer: C

65. A foundation measures 12 ft x 14 ft x 16 ft. Find the number of sacks of cement needed for 1:2:4 mixture.
A.302 C.356
B.598 D.404
Answer: B

66. A rectangular foundation cross-section has a bed plate dimension of 8 ft x 10 ft. The uniform clearance on each side 1 ft. The height of foundation is 4.5 ft. If the weight of the steel bar reinforcements needed is ½% of weight of foundation, find the weight of steel bars. Use concrete density of 2400 kg/m^3.
A.173.47 kg C.163.47 kg
B.183.47 kg D.153.47 kg
Answer: B

67. The charge in a Diesel engine consists of 18.34 grams of fuel, with lower heating value of 42,571 KJ/kg, and 409 grams of fuel and products of combustion. At the beginning of compression, t_1 = 60^{0}C. Let r_k = 14. For constant c_p = 1.11 KJ/kg-C, what should be the cut-off ratio in the corresponding ideal cycle?
A.2.05 C.5.34
B.2.97 D.2.34
Answer: B

68. In a Brayton cycle that operates between temperature limits of 300^{0}K and 1773^{0}K with k = 1.4, determine the temperature at the end of compression (isentropic) for maximum work of the cycle.
A.700^{0}K C.730^{0}K
B.690.5^{0}K D.350^{0}K
Answer: C

69. A windmill with a 12 m diameter rotor is to be installed at a location where the wind is blowing at an average velocity of 10 m/s. Using standard condition of air (1 atm, 25 deg C), determine the maximum power that can be generated by the windmill.
A.68 KW C.72 KW
D.74 KW D.70 KW
Answer: D

70. Consider a large furnace that can supply heat at a temperature of 2000 deg R at a steady rate of 3000 Btu/s. Determine the energy. Assume an environment temperature of 77 deg F.
A.2305.19 KW C.2325.19 KW
B.2315.19 KW D.2335.19 KW
Answer: B

71. A thermal power plant has a heat rate of 11,363 Btu/KW-hr. Find the thermal efficiency of the plant.
A.34% C.26%
B.30% D.24%
Answer: B

72. A fan is powered by a 0.5 hp motor and delivers air at a rate of 85 m^3/min. Determine the highest value for the average velocity of air mobilized by the fan. Take the density of air to be 1.18 kg/m^3.
A.18.23 m/s C.25.34 m/s
B.21.12 m/s D.32.23 m/s
Answer: B

73. An Ocean- Thermal Energy Conversion power plant generates 10,000 KW using a warm surface water inlet temperature of 26 deg C and a cold deep-water temperature of 15 deg C. On the basis of a 3 deg C drop in the temperature of the warm water and a 3 deg C rise in the temperature of the cold water due to removal and addition of heat, calculate the power required in KW to pump the cold-deep water to the surface and through the system heat exchanger if the required pumping pressure increase is 12kPa. Assume a Carnot cycle efficiency and density of cold water to be 1000 kg/m^3.
A.108 C.146
B.160 D.250
Answer: D

74. A plate-type solar energy collector with an absorbing surface covered by a glass plate is to receive an incident radiation of 800 W/m^2. The glass plate has a reflectivity of 0.12 and a transmissivity of 0.85. The absorbing surface has an absorptivity of 0.90. The area of the collector is 5m^2. How much solar energy in watts is absorbed by the collector?
A.2500 C.3510
B.3060 D.2880
Answer: B

75. A simple Rankine cycle produces 40 MW of power, 50 MW of process heated and rejects 50MW of heat to the surroundings. What is the utilization factor of this cogeneration cycle neglecting the pump work?
A.50% C.64%
B.80% D.60%
Answer: C

76. An ideal Brayton cycle has a net work output of 150 KJ/kg and backwork of 0.4. If both the turbine and the compressor had an isentropic efficiency of 80%, the net work output of the cycle would be:
A.50 KJ/kg C.98 KJ/kg
B.75 KJ/kg D.120 KJ/kg
Answer: B

77. Air enters a turbojet engine at 200 m/s at a rate of 20 kg/s, and exits at 800 m/s relative to the aircraft. The thrust developed by the engine is:
A.6 KN C.16 KN
B.20 KN D.12 KN
Answer: D

78. A thermal power has a net power 10 MW. The backwork ratio of the plant is 0.005. Determine the compressor work.
A.50.15 KW C.50.25 KW
B.50.35 KW D.50.45 KW
Answer: C

79. A 350 mm x 450 mm steam engine running at 280 rpm has an entrance steam condition of 2 MPa and 230°C and exit at 0.1 MPa. The steam consumption is 2000 kg/hr and mechanical efficiency is 85%. If indicated mean effective pressure is 600 kPa, determine brake thermal efficiency.At 2 MPa and 230°C (Table 3):h_1 = 2849.6 s_1 = 6.4423 At 0.1 MPa:s_f = 1.3026 h_f = 417.46 s_{fg} = 6.0568 h_{fg} = 2258 h_2 = 417.46 kJ/kg
A. 23.34% C. 14.16%
B. 15.25% D. 27.34%
Answer: B

80. Calculate the use factor of a power plant if the capacity factor is 35% and it operates 8000 hrs during the year?
A. 38.325 % C. 35.823 %
B. 33.825 % D. 32.538 %
Answer: A

81. A steam turbine receives 5000 kg/hr of steam at 5 MPa and 400°C and velocity of 30 m/sec. It leaves the turbine at 0.006 MPa and 85% quality and velocity of 15 m/sec. Radiation loss is 10,000 kJ/hr. Find the kW developed. At 5 MPa and 400°C: h_1 = 3195.7 kJ/kg s_1 = 6.6459 At 0.006 MPa:h_f = 151.53 h_{fg} = 2415.9
A. 1273.29 C. 1373.60
B. 2173.29 D. 7231.29
Answer: C

82. A steam turbine with 85% stage efficiency receives steam at 7 MPa and 550°C and exhausts as 20 kPa. Determine the turbine work.At 7 MPa and 550°C: h_1 = 3530.9 kJ/kg s_1 = 6.9486 At 20 kPa (0.020 MPa): s_f = 0.8320 h_f = 251.40 s_{fg} = 7.0766 h_{fg} = 2358.3
A. 1,117 kJ/kg C.1,123.34 kJ/kg
B. 1,132 kJ/kg D.1,054.95kJ/kg

Answer: D

83. How many identical turbines, operating at 139.0 rpm and 91% efficiency (specific speed = 5.4), are needed to exploit a head of 1200 ft and a flow of 1660 ft^3/s.
A. 2 turbines C. 3 turbines
B. 4 turbines D. 5 turbines
Answer: C

84. How many poles should a 60-Hz generator have, if it is connected to a turbine operating under a design head of 3000 ft with a flow of 82 cfs? Assume turbine specific speed and efficiency 3 and 84 percent respectively.
A. 10-pole C. 12-pole
B. 14-pole D. 16-pole
Answer: D

85. It is proposed to build a dam in a river where the flow rate is 10 m^3/sec and a 32-m drop in elevation can be achieved for flow through a turbine. If the turbine is 82 percent efficient, what maximum power that can be achieved? Specific gravity of river water is 0.998.
A. 2570 kW C. 3133 kW
B. 3820 kW D. 262 kW
Answer: A

86. What type of turbine delivers 25,000 bhp at 500 rpm under a net head of 5350 ft
A. Impulse turbine B. Francis turbine
B. Kaplan turbine D. Propeller turbine
Answer: A

87. A double-overhung impulse-turbine installation is to develop 20,000 hp at 275 rpm under a net head of 1100 ft. Determine the specific speed.
A. 4.34 C. 6.14
B. 203.61 D. 144
Answer: A

88. An impulse wheel at best produces 125 hp under a head of 210 ft. By what percent should the speed be increased for a 290-ft head?
A. 82.5% C. 17.5%
B. 72.41% D. 27.59%
Answer: C

89. A power plant has a steam operating header pressure of 150 psig dry and saturated with engine exhaust at atmospheric pressure. Initial feed-water temperature is 65°F. What will be the fuel saving in percent if a feed-water heater is installed using exhaust steam and heating the water to 205°F? Enthalpy of steam at header h = 1195.6 btu/lb.
A. 15.12 % C. 12.15 %
B. 12.04 % D. 21.21 %
Answer: B

90. Consider 4800 lb of steam per hour flowing through a pipe at 100 psia pressure. Assume a velocity of 5280 ft/min. What size of pipe is required? Specific volume of steam at 100 psia $v = 4.432\ ft^3/lb$.
A. 3 in C. 4 in
B. 5 in D. 6 in
Answer: C

91. A boiler plant generates 225,000 lb of steam and burns 13.9 tons of coal per hour. The coal has a heating value of 11,400 Btu/lb. A test of the particulates leaving the boiler shows that 3804 lb of particulate is being discharged per hour. What is the particulate discharged per million Btu heat input to the furnace?
A. 12 lb / 10^6 Btu C. 15 lb / 10^6 Btu
B. 14 lb / 10^6 Btu D. 16 lb/ 10^6 Btu
Answer: A

92. A piston moves inside a cylinder at a velocity of 6.0 m/s. The 160 mm. diameter piston is centrally located within the 160.2 mm. inside diameter cylinder. The film of oil is separating the piston from the cylinder has an absolute viscosity of 0.4 N-s/m^2. Assuming a linear velocity profile, find the shear stress in the oil. ($T = \mu(v / H)$)
A. 50,000 N/m^2 C. 24,000 N/m^2
B. 40,000 N/m^2 D. 34,000 N/m^2
Answer: C

93. How long must a current of 5.0 amperes pass through a 10 ohm resistor until a charge of 1200 coulombs passes through?
A. 1 min C. 3 min
B. 2 min D. 4 min
Answer: D

94. A car moving at 70 km/hr has a mass of 1700 kg. What force is necessary decelerate it at rate of 40 cm/s^2.
A. 0.680 N C. 680 N
B. 42.5 N D. 4250 N
Answer: C

95. A boy pulls a sled with a mass of 20kg horizontally over a surface with a coefficient of friction of 0.20. It takes him 10 minutes to pull the sled 100 yards. What is his average power output over these 10 minutes?
A. 4 W C. 8 W
B. 6 W D. 10 W
Answer: B

96. A force of 200 lb_f acts on a block at an angle 0f 28° with respect to horizontal. The block is pushed 2 feet horizontally. What is the work done by this force?
A. 215 J C. 480 J
B. 320 J D. 540 J
Answer: C

97. Two particles collide, stick together, and continue their motion together. Each particle has a mass of 10 g, and their respective velocities before the collision were 10m/s and 100 m/s. What is the energy of the system after the collision?
A. 21.8 J C. 42.8 J
B. 30.2 J D. 77.9 J
Answer: B

98. Two protons, each of charges 1.6 x 10^{-19}coulomb, are 3.4 micrometers apart. What is the change in the potential energy of the protons if they are brought 63 nanometers closer together?
A. 6.4 x 10^{-29} J C. 1.28 x 10^{-24} J
B. 7.16 x 10^{-24} J D. 3.21 x 10^{-24} J
Answer: C

99. A copper bar is 90 centimeters long at 86°F. What is the increase in its length when the bar is heated to 95°F? The linear expansion coefficient for copper, α, is 1.7 x 10^{-5}1/°C.
A. 2.12 x 10^{-5} m C. 5.25 x 10^{-5} m
B. 3.22 x 10^{-5} m D. 7.65 x 10^{-5} m
Answer: D

100. The change of enthalpy of an incompressible liquid with constant specific heat is given by:

$$h_2 - h_1 = c(T_2 - T_1) = \upsilon(p_2 - p_1)$$

Where,T_n = temperature at a state ηP_n = pressure at state $\eta\upsilon$ = specific volume of the liquid

Water, with $c\rho$ =4.18 kJ/kg.K and υ = 1.00 x 10^{-3} m^3/kg has the following final states: State I: T_1 = 19 °C ρ_1 = 1.013 x 10^5 PaState II: T_2 = 30 °C ρ_2 = 0.113 MPa What is the change in enthalpy from state I to state II?
A. 46.0 kJ/kg C. 46.0 kPa/kg
B. 46.0 kN/kg D. 56.0 kJ/kg
Answer: A

101. What is the change in enthalpy from state I to state II?
A. 46.0 kJ/kg C. 46.0 kPa/kg
B. 46.0 kN/kg D. 56.0 kJ/kg
Answer: A

102. Two liters of an ideal gas, at a temperature of T_1 = 25 °C and a pressure of P_1=0.101 MPa, are in a 10 cm diameter cylinder with a piston at one end. The piston is depressed, so that the cylinder is shortened by 10 centimeters. The temperature increases by 2 °C. What is the change in pressure?
A. 0.156 MPa C. 0.251 MPa
B. 0.167 MPa D. 0.327 Mpa
Answer: B

103. The average power output of a cylinder in a combustion engine is given by: $\bar{P} = pLAN$ Where p = average pressure on the piston during the stroke L = length of the piston stroke A = area of the piston head N = number strokes per second. An 8-cylinder engine has the following specifications at optimum speed:p = 283 kPaL = 14 cm d = diameter of piston head = 12 cm N = 1500 strokes/min. What is the average power output of this engine?
A. 89.5 N / s C. 89.5 x 10^3 J . m/s
B. 89.5 kW D. 89.5 kJ
Answer: B

104. What is the power required to transfer 97,000 coulombs of charge through a potentials rise of 50 volts in one hour?
A. 0.5 kW C. 1.3 kW
B. 0.9 kW D. 2.8 kW
Answer: C

105. A current of 7 amperes passes through a 12 ohm resistor. What is the power dissipated in the resistor?
A. 84 w C. 0.79 hp
B. 0.59 hp D. 7 hp
Answer: C

106. If the average energy in a nuclear reaction is 200 MeV / fission, what is the power output of a reactor if there are 2.34×10^{19} fissions per second?
A. 550 W C. 30 MW
B. 120 kW D. 750 MW
Answer: D

107. In an ideal standard Brayton cycle, 1.5 kg/s of air at 101 kPaa and 27 °C is compressed isentropically to a certain pressure and temperature after which the is added until the temperature becomes 1027 °C. Isentropic expansion occurs in the turbine. Determine the net power produced by the cycle.
a) 629.56 kW c) 592.65 kW
b) 529.76 kW d) 579.26 kW
Answer: B

108. In an air-standard Brayton cycle, air enters compressor at 1 bar and 15 °C. The pressure leaving the compressor is 0.6 MPaa and maximum temperature of the cycle is 1000 °C. What is the maximum net work, in kJ/kg?
a) 319.52 c) 392.51
b) 315.29 d) 352.19
Answer: D

109. The percent rating of water tube boiler is 200 %, factor of evaporation is 1.10, and heating surface is 400 ft^2. Determine the rate of evaporation, in kg/hr.
a) 1831 c) 1831
b) 1138 d) 1813
Answer: B

110. In a geothermal power plant, the mass flow rate of ground water is 4000 kg/s and the quality after throttling is 20%. If the turbine power is 80 MW, what is the change in enthalpy of steam at the inlet and outlet of the turbine?
a) 120 kJ/kg c) 100 kJ/kg
b) 200 kJ/kg d) 150 kJ/kg
Answer: C

111. A Rankine cycle operates with a thermal efficiency of 40 % and the factor of evaporation of the boiler is 1.15. Determine the mass flow rate of steam if the cycle power output is 5.5 MW.
a) 5.3 kg/s c) 4.3 kg/s
b) 3.5 kg/s d) 6.3 kg/s
Answer: A

112. A boiler operates at 82 % efficiency while the mass of steam generated is 490 200 kg in 6 hours. The enthalpy of steam is 3187 kJ/kg and feed is 604.83 kJ/kg while the fuel used for boiler has a heating value of 32 567.85 kJ/kg. Find the mass of fuel needed per day in metric tons.
a) 179.6 c) 189.6
b) 198.6 d) 169.8
Answer: C

113. A 80 MW power plant has an average load of 34 500 kW and a load factor of 0.75. Find the reserve power over a peak load power.
a) 14 000 kW c) 34 000 kW
b) 24 000 kW d) 4 000 kW
Answer: C

114. A turbine has a peripheral coefficient of 0.6. Find the runner diameter of the turbine if it operates at 450 rpm and a head of 60 m.
a) 0.874 m c) 0.784 m
b) 0.478 m d) 0.748 m
Answer: A

115. In a Rankine cycle, steam enters the turbine at 2.5MPa and a condenser pressure of 50KPa. What is the quality of steam at the turbine exhaust? Steam Properties: @ 2.5Mpaa, h = 2803.1 kJ/kg & s = 6.2575 kJ/kg-°K; @ 50kPaa, h_f = 340.49 kJ/kg, h_{fg} = 2305.4 kJ/kg, v_f = 0.00103 m^3/kg, s_f = 1.0910 kJ/kg-°K, s_{fg} = 6.5029 kJ/kg-°K.
a) 79.45 % c) 97.45 %
b) 59.75 % d) 95.55 %
Answer: A

116. An adiabatic turbine steam generating plant receives steam at a pressure of 7.0 MPa and 550°C (h = 3531 kJ/kg) and exhausts at a condenser pressure of 20kPa (h = 2290 kJ/kg). The turbine inlet is 3 meters higher than the turbine exit, inlet steam velocity is 15m/s and the exit is 300m/s. Calculate the turbine work in kJ/kg.
a) 1296.14 c) 1196.24
b) 1619.42 d) 1294.16
Answer: C

117. Determine the indicated power of a four-cylinder, 4-stroke, Diesel engine with 20-cm bore and 30-cm stroke running at 1000 rpm and has a reading of 450 kPa mean effective pressure in the indicator diagram.
a) 159.83 Hp c) 189.53 Hp
b) 158.93 Hp d) 198.53 Hp
Answer: C

118. Determine the indicated mean effective pressure of an engine, in psi, having a brake mean effective pressure of 750 kPa and 80 % mechanical efficiency.
a) 138 c) 137
b) 136 d) 135
Answer: B

119. The indicator card (actual p-V diagram) of an engine in a Diesel power plant indicates an area of 0.06 m^2 and length of 300 mm, and with a spring scale of 2500 kPa/m. The engine was tested using Prony brake with lever arm of 3 m and tare weight of 8 kN. Determine the mechanical efficiency if the engine is running at 600 rpm. The engine is 2-stroke and has 12 cylinders, 300 mm bore, and 450 mm stroke.
a) 78.01 % c) 79.01 %
b) 82.01 % d) 76.01 %
Answer: C

120. A 145 000-kW turbo-generator requires 690 000 kg/hr of steam at rated load and 23 000 kg/hr of steam at zero load. Determine the steam rate, in kg/kW-hr, at 75 % of its rated load.
a) 4.81 kg/kW-hr c) 3.81 kg/kW-hr
b) 5.81 kg/kW-hr d) 2.81 kg/kW-hr
Answer: A

121. A 1.5 MW Diesel power generating unit has a generator efficiency of 85 %. Determine the volume flow rate, in lps, of cooling water required for the engine at 18 °C temperature rise.
a) 21 lps c) 19 lps
b) 22 lps d) 23 lps
Answer: A

122. The water turbine of a 5-MW hydro-power plant has a specific speed of 40 rpm and a discharge of 2020 lps. What is the approximate diameter of the jet.
a) 191 mm c) 171 mm
b) 181 mm d) 161 mm
Answer: A

123. Indicator test that shows that the area of card is 33 mm^2, length of card is 50 mm. If spring scale is 1.72 MPa per mm, determine the MEP:
a) 1.781 Mpa c) 33 Mpa
b) 1.135 Mpa d) 50 Mpa
Answer: B

124. A Diesel power plant uses fuel with heating value of 45 038.8 kJ/kg. What is the density of fuel at 30 °C?
a) 0.7882 kg/li c) 0.8782 kg/li
b) 0.9887 kg/li d) 0.8878 kg/li
Answer: C

125. Determine the friction power of an engine if the frictional torque developed is 0.30 kN-m running 1200 rpm.
a) 47.7 kW c) 37.7 kW
b) 43.3 kw d) 33.3 kW
Answer: C

126. A 500 kW Diesel engine operates at 101.3 kPaa and 27 °C in Calamba City. If the engine will operates in Baguio City having 93 kPaa and 23 °C, what new brake power will be developed if mechanical efficiency is 85 %.
a) 455.96 kW c) 549.10 kW
b) 954.1 kW d) 495.1 kW
Answer: A

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