มหาวิทยาลัยสงขลานครินทร์

คณะวิศวกรรมศาสตร์

การสอบกลางภาค ประจำภาคการศึกษาที่ 1 ประจำปีการศึกษา 2554

วันที่ 4 สิงหาคม 2554 เวลา 09.00-12.00 น.

วิชา 216-332 Engineering Thermodynamics II ห้อง S 102 และ S 104

คำสั่ง

1. ข้อสอบมี 9 แผ่นรวมปก ประกอบด้วยปัญหา 5 ข้อ อ่านโจทย์ให้เข้าใจแล้วทำทุกข้อในข้อสอบ ถ้าทำเนื้อที่ไม่พอให้ทำต่อด้านหลังของแต่ละข้อ
2. อนุญาตให้นำเครื่องคิดเลขเข้าห้องสอบได้
3. อนุญาตให้นำกระดาษ A4 ที่จดด้วยลายมือ (ห้ามถ่ายเอกสาร) จำนวน 1 แผ่น เข้าห้องสอบได้
4. ไม่อนุญาตให้นำเอกสาร หนังสือ ตำราอื่นใดเข้าห้องสอบ ยกเว้นที่อนุญาตตามข้อ 3.

ชื่อ-สกุล..... รหัส.....

รศ.กำพล ประทีปชัยกูร

อ.สราวุธ โกนสร้าง

ผู้ออกข้อสอบ

ทุจริตในการสอบ โทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

ชื่อ-สกุล..... รหัส.....

1. A Saturated vapor of refrigerant-134a at 500 kPa is compressed by an adiabatic 1.5-kW compressor to an exit state of 1.6 MPa and entropy rises to 0.9222 kJ/kg·K. Neglecting the changes in kinetic and potential energies, determine;
    (a) the isentropic efficiency of the compressor,
    (b) the volume flow rate of the refrigerant at the compressor inlet, in L/min, and
    (c) the maximum volume flow rate at the inlet conditions that adiabatic 1.5-kW compressor can handle without violating the second law.

ชื่อ-สกุล..... รหัส.....

2. A 4-stroke, 3000-cc, 6-cylinder gasoline engine operates on the Otto cycle with a compression ratio of 7.279. The air is compressed at 90 kPa and 27°C. The maximum cycle temperature is 1127 °C. Utilizing air-standard assumption, determine;
   (a) the thermal efficiency of the engine,
   (b) the horsepower that the engine produces when operated at 5,500 rpm, and
   (c) MEP.

   (Given $R_{air@room\ temp}$=0.287 kPa·m^3/kg·K)

ชื่อ-สกุล..... รหัส.....

3. An ideal Diesel cycle with air as the working fluid has a compression ratio of 22 and a cutoff ratio of 1.8. At the beginning of the compression process, the working fluid is at 100 kPa, 27 °C, and 2000 cm^3. Utilizing the cold-air-standard assumption, state assumptions, draw process paths on P-V diagram, and determine;
   (a) the temperature and pressure of air at the end of each process,
   (b) the net work output and the thermal efficiency, and
   (c) the mean effective pressure.

   (Given R=0.287 kPa·m^3/kg·K, C_p=1.005 kJ/kg·K, and C_V=0.718 kJ/kg·K)

ชื่อ-สกุล..... รหัส.....

4. A gas turbine engine operates on the simple Brayton cycle. Air enters the engine at 90 kPa 17 °C. The compressor pressure ratio is 8.423 and the maximum temperature is 827 °C. The isentropic efficiency of compressor and turbine are 82.41 % and 89.27 %, respectively. Utilizing the air-standard assumption, determine;
   (a) the temperature at the exit of both compressor and turbine,
   (b) the back work ratio, and
   (c) the 2^{nd} law efficiency.

ชื่อ-สกุล..... รหัส.....

5. A gas-turbine engine with regeneration operates on the Brayton cycle. The pressure ratio is 8. The air enters the compressor at 300 K and turbine at 1400 K. The compressor and turbine efficiencies are 78 and 86 percent, respectively and the effectiveness of the regenerator is 75 percent. Accounting for the variation of specific heats of air with temperature, determine;

   (a) the back work ratio, and

   (b) the thermal efficiency of the cycle.

ชื่อ-สกุล..... รหัส.....

TABLE A-13

Superheated refrigerant-134a (*Concluded*)

T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K
	P = 0.50 MPa (T_{sat} = 15.74°C)				P = 0.60 MPa (T_{sat} = 21.58°C)				P = 0.70 MPa (T_{sat} = 26.72°C)			
Sat.	0.04086	253.64	256.07	0.9117	0.03408	238.74	259.19	0.9097	0.02918	241.42	261.85	0.9080
20	0.04188	239.40	260.34	0.9264								
30	0.04416	248.20	270.28	0.9597	0.03581	246.41	267.89	0.9388	0.02979	244.51	265.37	0.9197
40	0.04633	256.99	280.16	0.9918	0.03774	255.45	278.09	0.9719	0.03157	253.83	275.93	0.9539
50	0.04842	265.83	290.04	1.0229	0.03958	264.48	288.23	1.0037	0.03324	263.08	286.35	0.9867
60	0.05043	274.73	299.95	1.0531	0.04134	273.54	298.35	1.0346	0.03482	272.31	296.69	1.0182
70	0.05240	283.72	309.92	1.0825	0.04304	282.66	308.48	1.0645	0.03634	281.57	307.01	1.0487
80	0.05432	292.80	319.96	1.1114	0.04469	291.86	318.67	1.0938	0.03781	290.88	317.35	1.0784
90	0.05620	302.00	330.10	1.1397	0.04631	301.14	328.93	1.1225	0.03924	300.27	327.74	1.1074
100	0.05805	311.31	340.33	1.1675	0.04790	310.53	339.27	1.1505	0.04064	309.74	338.19	1.1358
110	0.05988	320.74	350.68	1.1949	0.04946	320.03	349.70	1.1781	0.04201	319.31	348.71	1.1637
120	0.06168	330.30	361.14	1.2218	0.05099	329.64	360.24	1.2053	0.04335	328.98	359.33	1.1910
130	0.06347	339.98	371.72	1.2484	0.05251	339.38	370.88	1.2320	0.04468	338.76	370.04	1.2179
140	0.06524	349.79	382.42	1.2746	0.05402	349.23	381.64	1.2584	0.04599	348.66	380.86	1.2444
150					0.05550	359.21	392.52	1.2844	0.04729	358.68	391.79	1.2706
160					0.05698	369.32	403.51	1.3100	0.04857	368.82	402.82	1.2963
	P = 0.80 MPa (T_{sat} = 31.33°C)				P = 0.90 MPa (T_{sat} = 35.53°C)				P = 1.00 MPa (T_{sat} = 39.39°C)			
Sat.	0.02547	243.78	264.15	0.9066	0.02255	245.88	266.18	0.9054	0.02020	247.77	267.97	0.9043
40	0.02691	252.13	273.66	0.9374	0.02325	250.32	271.25	0.9217	0.02029	248.39	268.68	0.9066
50	0.02846	261.62	284.39	0.9711	0.02472	260.09	282.34	0.9566	0.02171	258.48	280.19	0.9428
60	0.02992	271.04	294.98	1.0034	0.02609	269.72	293.21	0.9897	0.02301	268.35	291.36	0.9768
70	0.03131	280.45	305.50	1.0345	0.02738	279.30	303.94	1.0214	0.02423	278.11	302.34	1.0093
80	0.03264	289.89	316.00	1.0647	0.02861	288.87	314.62	1.0521	0.02538	287.82	313.20	1.0405
90	0.03393	299.37	326.52	1.0940	0.02980	298.46	325.28	1.0819	0.02649	297.53	324.01	1.0707
100	0.03519	308.93	337.08	1.1227	0.03095	308.11	335.96	1.1109	0.02755	307.27	334.82	1.1000
110	0.03642	318.57	347.71	1.1508	0.03207	317.82	346.68	1.1392	0.02858	317.06	345.65	1.1286
120	0.03762	328.31	358.40	1.1784	0.03316	327.62	357.47	1.1670	0.02959	326.93	356.52	1.1567
130	0.03881	338.14	369.19	1.2055	0.03423	337.52	368.33	1.1943	0.03058	336.88	367.46	1.1841
140	0.03997	348.09	380.07	1.2321	0.03529	347.51	379.27	1.2211	0.03154	346.92	378.46	1.2111
150	0.04113	358.15	391.05	1.2584	0.03633	357.61	390.31	1.2475	0.03250	357.06	389.56	1.2376
160	0.04227	368.32	402.14	1.2843	0.03736	367.82	401.44	1.2735	0.03344	367.31	400.74	1.2638
170	0.04340	378.61	413.33	1.3098	0.03838	378.14	412.68	1.2992	0.03436	377.66	412.02	1.2895
180	0.04452	389.02	424.63	1.3351	0.03939	388.57	424.02	1.3245	0.03528	388.12	423.40	1.3149
	P = 1.20 MPa (T_{sat} = 46.32°C)				P = 1.40 MPa (T_{sat} = 52.43°C)				P = 1.60 MPa (T_{sat} = 57.92°C)			
Sat.	0.01663	251.03	270.99	0.9023	0.01405	253.74	273.40	0.9003	0.01208	256.00	275.33	0.8982
50	0.01712	254.98	275.52	0.9164								
60	0.01835	265.42	287.44	0.9527	0.01495	262.17	283.10	0.9297	0.01233	258.48	278.20	0.9069
70	0.01947	275.59	298.96	0.9868	0.01603	272.87	295.31	0.9658	0.01340	269.89	291.33	0.9457
80	0.02051	285.62	310.24	1.0192	0.01701	283.29	307.10	0.9997	0.01435	280.78	303.74	0.9813
90	0.02150	295.59	321.39	1.0503	0.01792	293.55	318.63	1.0319	0.01521	291.39	315.72	1.0148
100	0.02244	305.54	332.47	1.0804	0.01878	303.73	330.02	1.0628	0.01601	301.84	327.46	1.0467
110	0.02335	315.50	343.52	1.1096	0.01960	313.88	341.32	1.0927	0.01677	312.20	339.04	1.0773
120	0.02423	325.51	354.58	1.1381	0.02039	324.05	352.59	1.1218	0.01750	322.53	350.53	1.1069
130	0.02508	335.58	365.68	1.1660	0.02115	334.25	363.86	1.1501	0.01820	332.87	361.99	1.1357
140	0.02592	345.73	376.83	1.1933	0.02189	344.50	375.15	1.1777	0.01887	343.24	373.44	1.1638
150	0.02674	355.95	388.04	1.2201	0.02262	354.82	386.49	1.2048	0.01953	353.66	384.91	1.1912
160	0.02754	366.27	399.33	1.2465	0.02333	365.22	397.89	1.2315	0.02017	364.15	396.43	1.2181
170	0.02834	376.69	410.70	1.2724	0.02403	375.71	409.36	1.2576	0.02080	374.71	407.99	1.2445
180	0.02912	387.21	422.16	1.2980	0.02472	386.29	420.90	1.2834	0.02142	385.35	419.62	1.2704
190					0.02541	396.96	432.53	1.3088	0.02203	396.08	431.33	1.2960
200					0.02608	407.73	444.24	1.3338	0.02263	406.90	443.11	1.3212

ชื่อ-สกุล..... รหัส.....

Ideal-gas properties of air

T K	h kJ/kg	P_r	u kJ/kg	v_r	s° kJ/kg · K	T K	h kJ/kg	P_r	u kJ/kg	v_r	s° kJ/kg · K
200	199.97	0.3363	142.56	1707.0	1.29559	580	586.04	14.38	419.55	115.7	2.37348
210	209.97	0.3987	149.69	1512.0	1.34444	590	596.52	15.31	427.15	110.6	2.39140
220	219.97	0.4690	156.82	1346.0	1.39105	600	607.02	16.28	434.78	105.8	2.40902
230	230.02	0.5477	164.00	1205.0	1.43557	610	617.53	17.30	442.42	101.2	2.42644
240	240.02	0.6355	171.13	1084.0	1.47824	620	628.07	18.36	450.09	96.92	2.44356
250	250.05	0.7329	178.28	979.0	1.51917	630	683.63	19.84	457.78	92.84	2.46048
260	260.09	0.8405	185.45	887.8	1.55848	640	649.22	20.64	465.50	88.99	2.47716
270	270.11	0.9590	192.60	808.0	1.59634	650	659.84	21.86	473.25	85.34	2.49364
280	280.13	1.0889	199.75	738.0	1.63279	660	670.47	23.13	481.01	81.89	2.50985
285	285.14	1.1584	203.33	706.1	1.65055	670	681.14	24.46	488.81	78.61	2.52589
290	290.16	1.2311	206.91	676.1	1.66802	680	691.82	25.85	496.62	75.50	2.54175
295	295.17	1.3068	210.49	647.9	1.68515	690	702.52	27.29	504.45	72.56	2.55731
300	300.19	1.3860	214.07	621.2	1.70203	700	713.27	28.80	512.33	69.76	2.57277
305	305.22	1.4686	217.67	596.0	1.71865	710	724.04	30.38	520.23	67.07	2.58810
310	310.24	1.5546	221.25	572.3	1.73498	720	734.82	32.02	528.14	64.53	2.60319
315	315.27	1.6442	224.85	549.8	1.75106	730	745.62	33.72	536.07	62.13	2.61803
320	320.29	1.7375	228.42	528.6	1.76690	740	756.44	35.50	544.02	59.82	2.63280
325	325.31	1.8345	232.02	508.4	1.78249	750	767.29	37.35	551.99	57.63	2.64737
330	330.34	1.9352	235.61	489.4	1.79783	760	778.18	39.27	560.01	55.54	2.66176
340	340.42	2.149	242.82	454.1	1.82790	780	800.03	43.35	576.12	51.64	2.69013
350	350.49	2.379	250.02	422.2	1.85708	800	821.95	47.75	592.30	48.08	2.71787
360	360.58	2.626	257.24	393.4	1.88543	820	843.98	52.59	608.59	44.84	2.74504
370	370.67	2.892	264.46	367.2	1.91313	840	866.08	57.60	624.95	41.85	2.77170
380	380.77	3.176	271.69	343.4	1.94001	860	888.27	63.09	641.40	39.12	2.79783
390	390.88	3.481	278.93	321.5	1.96633	880	910.56	68.98	657.95	36.61	2.82344
400	400.98	3.806	286.16	301.6	1.99194	900	932.93	75.29	674.58	34.31	2.84856
410	411.12	4.153	293.43	283.3	2.01699	920	955.38	82.05	691.28	32.18	2.87324
420	421.26	4.522	300.69	266.6	2.04142	940	977.92	89.28	708.08	30.22	2.89748
430	431.43	4.915	307.99	251.1	2.06533	960	1000.55	97.00	725.02	28.40	2.92128
440	441.61	5.332	315.30	236.8	2.08870	980	1023.25	105.2	741.98	26.73	2.94468
450	451.80	5.775	322.62	223.6	2.11161	1000	1046.04	114.0	758.94	25.17	2.96770
460	462.02	6.245	329.97	211.4	2.13407	1020	1068.89	123.4	776.10	23.72	2.99034
470	472.24	6.742	337.32	200.1	2.15604	1040	1091.85	133.3	793.36	23.29	3.01260
480	482.49	7.268	344.70	189.5	2.17760	1060	1114.86	143.9	810.62	21.14	3.03449
490	492.74	7.824	352.08	179.7	2.19876	1080	1137.89	155.2	827.88	19.98	3.05608
500	503.02	8.411	359.49	170.6	2.21952	1100	1161.07	167.1	845.33	18.896	3.07732
510	513.32	9.031	366.92	162.1	2.23993	1120	1184.28	179.7	862.79	17.886	3.09825
520	523.63	9.684	374.36	154.1	2.25997	1140	1207.57	193.1	880.35	16.946	3.11883
530	533.98	10.37	381.84	146.7	2.27967	1160	1230.92	207.2	897.91	16.064	3.13916
540	544.35	11.10	389.34	139.7	2.29906	1180	1254.34	222.2	915.57	15.241	3.15916
550	555.74	11.86	396.86	133.1	2.31809	1200	1277.79	238.0	933.33	14.470	3.17888
560	565.17	12.66	404.42	127.0	2.33685	1220	1301.31	254.7	951.09	13.747	3.19834
570	575.59	13.50	411.97	121.2	2.35531	1240	1324.93	272.3	968.95	13.069	3.21751

มีต่อหน้า 9

ชื่อ-สกุล..... รหัส.....

TABLE A–17

Ideal-gas properties of air (*Concluded*)

T K	h kJ/kg	P_r	u kJ/kg	v_r	$s°$ kJ/kg · K	T K	h kJ/kg	P_r	u kJ/kg	u v_r	$s°$ kJ/kg · K
1260	1348.55	290.8	986.90	12.435	3.23638	1600	1757.57	791.2	1298.30	5.804	3.52364
1280	1372.24	310.4	1004.76	11.835	3.25510	1620	1782.00	834.1	1316.96	5.574	3.53879
1300	1395.97	330.9	1022.82	11.275	3.27345	1640	1806.46	878.9	1335.72	5.355	3.55381
1320	1419.76	352.5	1040.88	10.747	3.29160	1660	1830.96	925.6	1354.48	5.147	3.56867
1340	1443.60	375.3	1058.94	10.247	3.30959	1680	1855.50	974.2	1373.24	4.949	3.58335
1360	1467.49	399.1	1077.10	9.780	3.32724	1700	1880.1	1025	1392.7	4.761	3.5979
1380	1491.44	424.2	1095.26	9.337	3.34474	1750	1941.6	1161	1439.8	4.328	3.6336
1400	1515.42	450.5	1113.52	8.919	3.36200	1800	2003.3	1310	1487.2	3.994	3.6684
1420	1539.44	478.0	1131.77	8.526	3.37901	1850	2065.3	1475	1534.9	3.601	3.7023
1440	1563.51	506.9	1150.13	8.153	3.39586	1900	2127.4	1655	1582.6	3.295	3.7354
1460	1587.63	537.1	1168.49	7.801	3.41247	1950	2189.7	1852	1630.6	3.022	3.7677
1480	1611.79	568.8	1186.95	7.468	3.42892	2000	2252.1	2068	1678.7	2.776	3.7994
1500	1635.97	601.9	1205.41	7.152	3.44516	2050	2314.6	2303	1726.8	2.555	3.8303
1520	1660.23	636.5	1223.87	6.854	3.46120	2100	2377.7	2559	1775.3	2.356	3.8605
1540	1684.51	672.8	1242.43	6.569	3.47712	2150	2440.3	2837	1823.8	2.175	3.8901
1560	1708.82	710.5	1260.99	6.301	3.49276	2200	2503.2	3138	1872.4	2.012	3.9191
1580	1733.17	750.0	1279.65	6.046	3.50829	2250	2566.4	3464	1921.3	1.864	3.9474

Note: The properties P_r (relative pressure) and v_r (relative specific volume) are dimensionless quantities used in the analysis of isentropic processes, and should not be confused with the properties pressure and specific volume.

Source: Kenneth Wark, *Thermodynamics*, 4th ed. (New York: McGraw-Hill, 1983), pp. 785–86, table A–5. Originally published in J. H. Keenan and J. Kaye, *Gas Tables* (New York: John Wiley & Sons, 1948).

Air