INSTRUCTIONS:

Fill out the hazard analysis and risk assessment below.

HA-001 should be for the lane departure warning function as discussed in the lecture.

HA-002 should be for the lane keeping assistance function as discussed in the lecture.

Then come up with your own situations and hazards for the lane assistance system. Fill in the HA-003 and HA-004 rows.

When finished, export your spreadsheet as a pdf file so that a reviewer can easily see your work.

Hazard ID	**Situational Analysis**							**Hazard Identification**					
	Operational Mode	**Operational Scenario**	**Environmental Details**	**Situation Details**	**Other Details (optional)**	**Item Usage (function)**	**Situation Description**	**Function**	**Deviation**	**Deviation Details**	**Hazardous Event (resulting effect)**	**Event Details**	**Hazardous Event Description**
HA-001	OM03-Normal driving	OS04-Highway	EN06-Rain (slippery roa	SD02-High speed		IU01-Correctly used	Normal driving on a highway during rain	Lane Departure	DV04-Actor effect	The LDW function applies an	EV00-Collision with othe	During the departure system apply	The LDW function applies an osci
HA-002	OM03-Normal driving	OS03-Country Road	EN01-Normal conditions	SD02-High speed		IU02-Incorrectly	Normal driving on country roads during	Lane Keeping	DV03-Function	The lane keeping assistance	EV00-Collision with othe	Driver is always activating the LKA	The lane keeping assistance was
HA-003	OM03-Normal driving	OS07-Road with gradient	EN01-Normal conditions	SD03-Normal acceleration		IU01-Correctly used	Normal driving on a gradient road during	Lane Keeping	DV19-Sensor	Due the gradient road ,	EV04-Car comes off the	Camera detects the lane position	Due the gradient road , camera
HA-004	OM03-Normal driving	OS02-City Road	EN01-Normal conditions	SD03-Normal acceleration		IU01-Correctly used	Normal driving on city road during normal	Lane Keeping	DV07-Actor actio	EPS has delay in	EV04-Car comes off the	EPS has communication bus load	EPS has delay in communcation

Hazardous Event Classification						Determination of ASIL and Safety Goals	
Exposure (of situation)	**Rationale (for exposure)**	**Severity (of potential harm)**	**Rationale (for severity)**	**Controllability (of hazardous event)**	**Rationale (for controllability)**	**ASIL Determination**	**Safety Goal**
E3-Medium	Vehicle is moving with high speed	S3-Life-threatening or fatal	Vehicle could lose	C3-Difficult to control or	The driver will face difficulty in controlling the vehicle	C	System should have a threshold to limit the torque in such case
E2-Low	It's not the normal usage of the	S3-Life-threatening or fatal	Vehicle could lose	C3-Difficult to control or	hands aren't on the wheel at high speeds, a vehicle	B	The lane keeping assistance function
E4-High	This gradient can be cause on many	S2-Severe and life-	incorrect calculation of	C2-Normally controllable	Due the driver is moving with normal acceleration	B	Camera sensor should has some sort of
E2-Low	Bus load should be managed and	S1-Light and moderate inju	Delay in angle is less	C2-Normally controllable	Due the driver is moving with normal acceleration	QM	LKA should be activate if the actual

EXAMPLE DISCUSSED IN THE PROJECT INSTRUCTIONS - Headlamp System

Hazard ID	Situational Analysis								
	Operational Mode	Operational Scenario	Environmental Details	Situation Details (optional)	Other Details (optional)	Item Usage (function)	Situation Description	Function	Deviation
HA-001	Normal Driving	City Road	Normal Conditions	Low Speed	Night time + Obstacle on the	Correctly Used	Normal Driving on a City Road in Normal	Low beam illuminates the	Function not activated

MORE EXAMPLES - Headlamp System

Hazard ID	Situation Analysis								
	Operational Mode	Operational Scenario	Environmental Details	Situation Details (optional)	Other Details (optional)	Item Usage (function)	Situation Description	Function	Deviation
HA-001	OM03 - Normal Driving	OS01 - City Road	EN01 - Normal conditions	SD03 - Low speed	Night time + Obstacle on the	IU01 - Correctly used	Normal Driving on City Road during Normal	Low beam illuminates the	DV01 - Function not activated
HA-002	OM03 - Normal Driving	OS01 - City Road	EN04 - Snowfall (degraded view)	SD03 - Low speed	Night time + Obstacle on the	IU01 - Correctly used	Normal Driving on City Road during Snowfall	Low beam illuminates the	DV01 - Function not activated
HA-003	OM03 - Normal Driving	OS03 - Highway	EN04 - Snowfall (degraded view)	SD03 - High speed	Night time + Obstacle on the	IU01 - Correctly used	Normal Driving on Highway during Snowfall	Low beam illuminates the	DV01 - Function not activated
HA-004	OM03 - Normal Driving	OS02 - Country Road	EN01 - Normal conditions	SD02 - High speed	Night time + Oncoming	IU01 - Correctly used	Normal Driving on Country Road during Normal	Low beam illuminates the	DV01 - Function not activated
HA-005	OM03 - Normal Driving	OS02 - Country Road	EN04 - Snowfall (degraded view)	SD04 - High speed	Night time + Obstacle on the	IU01 - Correctly used	Normal Driving on Country Road during Snowfall	Low beam illuminates the	DV01 - Function not activated

Hazard Identification				Hazardous Event Classification				
Deviation Details	**Hazardous Event (resulting effect)**	**Event Details**	**Hazardous Event Description**	**Exposure (of situation)**	**Rationale (for exposure)**	**Severity (of potential harm)**	**Rationale (for severity)**	**Controllability (of hazardous event)**
Both headlights stop working	Front collision with obstacle	Vehicle crashes into the	Total loss of low beam	E4 - High probability	night driving in the city is a regular	S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general

Hazard Identification				Hazardous Event Classification				
Deviation Details	**Hazardous Event (resulting effect)**	**Event Details**	**Hazardous Event Description**	**Exposure (of situation)**	**Rationale (for exposure)**	**Severity (of potential harm)**	**Rationale (for severity)**	**Controllability (of hazardous event)**
Both headlights stop working	EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam	E4 - High probability	night driving in the city is a regular	S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general
Both headlights stop working	EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam	E1 - Very low probability	night driving in the city on	S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low	C1 - Simply controllable
Both headlights stop working	EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam	E2 - Low probability	High driving is part of regular	S3 - Life-threatening or fatal injuries	On highway speed of vehicle is expected to be high	C2 - Normally controllable
Both headlights stop working	EV08 - Collision with other vehicle	Vehicle crashes into the	Total loss of low beam	E4 - High probability	country driving is part of regular	S3 - Life-threatening or fatal injuries	On country roads speed of vehicle is expected to be high	C1 - Simply controllable
Both headlights stop working	EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low beam	E2 - Low probability	country driving is part of regular	S3 - Life-threatening or fatal injuries	On country roads speed of vehicle is expected to be high	C3 - Difficult to control or uncontrollable

	Determination of ASIL and Safety Goals	
Rationale (for controllability)	ASIL Determination	Safety Goal
At city speed, most drivers will be able to	QM	Total Loss of Beam Shall

	Determination of ASIL and Safety Goals	
Rationale (for controllability)	ASIL Determination	Safety Goal
At city speed, most drivers will be able to	QM	Total loss of low beam
On completely unilluminated city roads,	QM	Total loss of low beam
When driving on highway with low beam, it	A	Total loss of low beam
Since there is usually no other form of	B	Total loss of low beam
Since there is usually no other form of	B	Total loss of low beam

Hazard & Risk Analysis Definitions

Operational Mode

ID	Mode	Remarks	Reference
OM01	Parked	Car is parked, ignition is off	OM01 - Parked
OM02	Ignition on	Car is parked, ignition is on	OM02 - Ignition on
OM03	Normal driving	Car is driving	OM03 - Normal driving
OM04	Backward driving	Car is driving	OM04 - Backward driving
OM05	Degraded driving	Limp home mode	OM05 - Degraded driving
OM06	Towing (active)	Towing another car	OM06 - Towing (active)
OM07	Towing (passive)	Beeing towed by another car	OM07 - Towing (passive)
OM08	Service	Vehicle is in repair garage	OM08 - Service
OM09	N/A	not applicable or not relevant	OM09 - N/A

Operational Scenario

ID	Scenario	Remarks	Reference
OS01	Any Road	road type	OS01 - Any Road
OS02	City Road	road type	OS02 - City Road
OS03	Country Road	road type	OS03 - Country Road
OS04	Highway	road type	OS04 - Highway
OS05	Mountain Pass	road type	OS05 - Mountain Pass
OS06	Off Road	road type	OS06 - Off Road
OS07	Road with gradient	road attribute	OS07 - Road with gradient
OS08	Road with bump	road attribute	OS08 - Road with bump
OS09	Road tunnel	road attribute	OS09 - Road tunnel
OS10	Road with construction site	road attribute	OS10 - Road with construction site
OS11	N/A	not applicable or not relevant	OS11 - N/A

Situation Details

ID	Scenario	Remarks	Reference
SD01	Low speed	driving attribute	SD01 - Low speed
SD02	High speed	driving attribute	SD02 - High speed
SD03	Normal acceleration	driving attribute	SD03 - Normal acceleration
SD04	High acceleration	driving attribute	SD04 - High acceleration
SD05	Normal braking	driving attribute	SD05 - Normal braking
SD06	High braking	driving attribute	SD06 - High braking
SD07	N/A	not applicable or not relevant	SD07 - N/A

Item Usage

ID	Mode	Remarks	Reference
IU01	Correctly used	Intended usage	IU01 - Correctly used
IU02	Incorrectly used	Unintended usage (foreseeable)	IU02 - Incorrectly used
IU03	N/A	not applicable or not relevant	IU03 - N/A

Environmental Details

ID	Scenario	Remarks	Reference
EN01	Normal conditions	weather attribute	EN01 - Normal conditions
EN02	Sun blares (degraded view)	weather attribute	EN02 - Sun blares (degraded view)
EN03	Fog (degraded view)	weather attribute	EN03 - Fog (degraded view)
EN04	Snowfall (degraded view)	weather attribute	EN04 - Snowfall (degraded view)
EN05	Cross-wind (lateral force)	weather attribute	EN05 - Cross-wind (lateral force)
EN06	Rain (slippery road)	road attribute	EN06 - Rain (slippery road)
EN07	Snow (slippery road)	road attribute	EN07 - Snow (slippery road)
EN08	Glace (slippery road)	road attribute	EN08 - Glace (slippery road)
EN09	N/A	not applicable or not relevant	EN09 - N/A

Deviation

ID	Deviation (Guideword)	Remarks	Reference
DV01	Function not activated	Activation error	DV01 - Function not activated
DV02	Function unexpectedly activated	Activation error	DV02 - Function unexpectedly activated
DV03	Function always activated	Activation error	DV03 - Function always activated
DV04	Actor effect is too much	Quantitative error	DV04 - Actor effect is too much
DV05	Actor effect is too less	Quantitative error	DV05 - Actor effect is too less
DV06	Actor action too early	Timing error	DV06 - Actor action too early
DV07	Actor action too late	Timing error	DV07 - Actor action too late
DV08	Actor action before	Sequence error	DV08 - Actor action before
DV09	Actor action after	Sequence error	DV09 - Actor action after
DV10	Actor effect is reverse	Logical error	DV10 - Actor effect is reverse
DV11	Actor effect is wrong	Logical error	DV11 - Actor effect is wrong
DV12	Sensor sensitivity is too high	Quantitative error	DV12 - Sensor sensitivity is too high
DV13	Sensor sensitivity is too low	Quantitative error	DV13 - Sensor sensitivity is too low
DV14	Sensor detection too early	Timing error	DV14 - Sensor detection too early
DV15	Sensor detection too late	Timing error	DV15 - Sensor detection too late
DV16	Sensor detection before	Sequence error	DV16 - Sensor detection before
DV17	Sensor detection after	Sequence error	DV17 - Sensor detection after
DV18	Sensor detection is reverse	Logical error	DV18 - Sensor detection is reverse
DV19	Sensor detection is wrong	Logical error	DV19 - Sensor detection is wrong
DV20	N/A	not applicable or not relevant	DV20 - N/A

Hazardous Events (possibe effects)

ID	Hazardous Event	Remarks	Reference
EV-07	None		EV-07 - None
EV-06	Front collision with oncoming traffic		EV-06 - Front collision with oncoming traffic
EV-05	Front collision with ahead traffic		EV-05 - Front collision with ahead traffic
EV-04	Front collision with obstacle		EV-04 - Front collision with obstacle
EV-03	Rear collision with trailing traffic		EV-03 - Rear collision with trailing traffic
EV-02	Side collision with other traffic		EV-02 - Side collision with other traffic
EV-01	Side collision with obstacle		EV-01 - Side collision with obstacle
EV00	Collision with other vehicle		EV00 - Collision with other vehicle
EV01	Collision with train		EV01 - Collision with train
EV02	Collision with pedestrian		EV02 - Collision with pedestrian
EV03	Car spins out of control		EV03 - Car spins out of control
EV04	Car comes off the road		EV04 - Car comes off the road
EV05	Car catches file		EV05 - Car catches file
EV06	N/A		EV06 - N/A

Exposure

ID	Description	Duration (of situation)	Frequency (of situation)	Reference
E0	Incredible			E0 - Incredible
E1	Very low probability	Not specified	Occurs less often than once a year for the great majority of drivers	E1 - Very low probability
E2	Low probability	<1 % of average operating time	Occurs a few times a year for the great majority of drivers	E2 - Low probability
E3	Medium probability	1 % to 10 % of average operating time	Occurs once a month or more often for an average driver	E3 - Medium probability
E4	High probability	>10 % of average operating time	Occurs during almost every drive on average	E4 - High probability

Severity

ID	Description	Remarks	Probability of Injuries	Reference
S0	No injuries	No injuries	AIS 0 and less than 10 % probability of AIS 1-6	S0 - No injuries
S1	Light and moderate injuries	Light and moderate injuries	More than 10 % probability of AIS 1-6 (and not S2 or S3)	S1 - Light and moderate injuries
S2	Severe and life-threatening injuries	Severe and life-threatening injuries (survival probable)	More than 10 % probability of AIS 3-6 (and not S3)	S2 - Severe and life-threatening injuries
S3	Life-threatening or fatal injuries	Life-threatening injuries (survival uncertain), fatal injuries	More than 10 % probability of AIS 5-6	S3 - Life-threatening or fatal injuries

Controllability

ID	Description	Remarks	Reference
C0	Controllable in general	Controllable in general	C0 - Controllable in general
C1	Simply controllable	99 % or more of all drivers or other traffic participants are usually able to avoid harm	C1 - Simply controllable
C2	Normally controllable	90 % or more of all drivers or other traffic participants are usually able to avoid harm	C2 - Normally controllable
C3	Difficult to control or uncontrollable	Less than 90 % of all drivers or other traffic participants are usually able, or barely able, to avoid harm	C3 - Difficult to control or uncontrollable

Controllability	Exposure	Severity			
		S0	S1	S2	S3
C1	E1	QM	QM	QM	QM
	E2	QM	QM	QM	QM
	E3	QM	QM	QM	A
	E4	QM	QM	A	B
C2	E1	QM	QM	QM	QM
	E2	QM	QM	QM	A
	E3	QM	QM	A	B
	E4	QM	A	B	C
C3	E1	QM	QM	QM	A
	E2	QM	QM	A	B
	E3	QM	A	B	C
	E4	QM	B	C	D