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						Hazardous Event Classification						Determination of ASIL and Safety Goals	
	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	Exposure (of situation)	Rationale (for exposure)	Severity (of potential harm)	Rationale (for severity)	Controllability (of hazardous event)	Rationale (for controllability)	ASIL Determination	Safety Goal
HA-001	OM03 - Normal Driving	OS04 - Highway	EN06 - Rain (slippery road)	SD02 - High speed		IU01 - Correctly used	Normal driving on a highway during rain (slippery road) with high speed and correctly used system.	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	DV04 - Actor effect is too much	The LDW function applies an oscillating torque with very high torque (above limit).	EV00 - Collition with other vehicle.	High haptic feedback can affect driver's ability to steer as intented. The driver loose control and could collide with another vehicle or side of the road.	The Lane Departure Warning function applies an oscillating torque with very high torque (above limit.)	E3 - Medium probability	Driving on a highway with rain could happen between 1% and 10% of the time operating the vehicle.	S3 - Life-threatening or fatal injuries	Collitions at high speed could cause fatal injuries.	C3 - Difficult to control or uncontrollable	The driver can be startled and loose control if the steering wheel vibrates too much.	C	The oscillating steering torque from the Lane Departure Warning function shall be limited.
HA-002	OM03 - Normal Driving	OM03 - Normal Driving	EN01 - Normal conditions	SD02 - High speed		IU02 - Incorrectly used	Normal driving on a country road during normal conditions with high speed and incorrectly used system.	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV03 - Function is always activated	Lane Keeping function is always activated	EV00 - Collition with other vehicle.	The driver does not focus on driving and use the system as self-driving system	The driver do not use the function properly.	E2 - Low probability	When driving a country road, drivers mostly pay attention to the road. Less than 1% of the time operating the vehicle.	S3 - Life-threatening or fatal injuries	Collitions at high speed could cause fatal injuries.	C3 - Difficult to control or uncontrollable	On country roads, drivers without concentration on the road may not have full controllability	B	The Lane Keeping Assistance function shall be time limited, and additional steering torque shall end after a given time interval so the driver cannot misuse the system for autonomous driving.
HA-003	OM03 - Normal Driving	OS04 - Highway	EN06 - Rain (slippery road)	SD02 - High speed		IU01 - Correctly used	Normal driving on a highway during rain (slippery road) with high speed and correctly used system.	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	DV05 - Actor effect is too low	The LDW function applies an oscillating torque with very low torque (below limit).	EV00 - Collition with other vehicle.	Low haptic feedback can affect driver's ability to steer as intented. The driver doesn't realise they drift away from the center and could collide with another vehicle or side of the road.	The Lane Departure Warning function applies an oscillating torque with very low torque (below limit.)	E3 - Medium probability	Driving on a highway with rain could happen between 1% and 10% of the time operating the vehicle.	S3 - Life-threatening or fatal injuries	Collitions at high speed could cause fatal injuries.	C3 - Difficult to control or uncontrollable	The driver trusts the system so they do not realise they drift away from the center and loose attention	C	The oscillating steering torque from the Lane Departure Warning function shall be limited.
HA-004	OM03 - Normal Driving	OS03 - Country Road	EN01 - Normal conditions	SD02 - High speed		IU01 - Correctly used	Normal driving on a country road during normal conditions with high speed and correctly used system.	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV02 - Function unexpectedly activated	The camera sensor stop working and the Lane Keeping Assistance function continues to be activated.	EV00 - Collition with other vehicle.	The Lane Keeping Assistance system continues to be activated and applies inappropriate torque to the vehicle so the driver has potential collition with other vehicle.	The Lane Keeping Assistance start acting randomly when the camera sensor is not working.	E3 - Medium probability	Driving on a highway with rain could happen between 1% and 10% of the time operating the vehicle.	S3 - Life-threatening or fatal injuries	Collitions at high speed could cause fatal injuries.	C3 - Difficult to control or uncontrollable	When the driver looses control of the vechicle it is difficult to realize the situation and act accordently.	C	The Lane Keeping Assistance function shall be deactivated when the camera sensor stop working.

EXAMPLE DISCUSSED IN THE PROJECT INSTRUCTIONS - Headlamp System

Hazard ID		
	Operational Mode	**Operational Scenario**
HA-001	Normal Driving	City Road

MORE EXAMPLES - Headlamp System

Hazard ID		
	Operational Mode	**Operational Scenario**
HA-001	OM03 - Normal Driving	OS01 - City Road
HA-002	OM03 - Normal Driving	OS01 - City Road
HA-003	OM03 - Normal Driving	OS03 - Highway
HA-004	OM03 - Normal Driving	OS02 - Country Road
HA-005	OM03 - Normal Driving	OS02 - Country Road

Situational Analysis			
Environmental Details	**Situation Details (optional)**	**Other Details (optional)**	**Item Usage (function)**
Normal Conditions	Low Speed	Night time + Obstacle on	Correctly Used

Situation Analysis			
Environmental Details	**Situation Details (optional)**	**Other Details (optional)**	**Item Usage (function)**
EN01 - Normal conditions	SD03 - Low speed	Night time + Obstacle on	IU01 - Correctly used
EN04 - Snowfall (degraded view)	SD03 - Low speed	Night time + Obstacle on	IU01 - Correctly used
EN04 - Snowfall (degraded view)	SD03 - High speed	Night time + Obstacle on	IU01 - Correctly used
EN01 - Normal conditions	SD02 - High speed	Night time + Oncoming	IU01 - Correctly used
EN04 - Snowfall (degraded view)	SD04 - High speed	Night time + Obstacle on	IU01 - Correctly used

	Hazard Id
Situation Description	**Function**	**Deviation**	**Deviation Details**
Normal Driving on a City Road in Normal	Low beam illuminates the	Function not activated	Both headlights stop working

	Hazard Id
Situation Description	**Function**	**Deviation**	**Deviation Details**
Normal Driving on City Road during Normal	Low beam illuminates the	DV01 - Function not activated	Both headlights stop working
Normal Driving on City Road during Snowfall	Low beam illuminates the	DV01 - Function not activated	Both headlights stop working
Normal Driving on Highway during Snowfall	Low beam illuminates the	DV01 - Function not activated	Both headlights stop working
Normal Driving on Country Road during Normal	Low beam illuminates the	DV01 - Function not activated	Both headlights stop working
Normal Driving on Country Road during Snowfall	Low beam illuminates the	DV01 - Function not activated	Both headlights stop working

entification

Hazardous Event (resulting effect)	Event Details	Hazardous Event Description	Exposure (of situation)
Front collision with obstacle	Vehicle crashes into the	Total loss of low	E4 - High probability

entification

Hazardous Event (resulting effect)	Event Details	Hazardous Event Description	Exposure (of situation)
EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low	E4 - High probability
EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low	E1 - Very low probability
EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low	E2 - Low probability
EV08 - Collision with other vehicle	Vehicle crashes into the	Total loss of low	E4 - High probability
EV04 - Front collision with obstacle	Vehicle crashes into the	Total loss of low	E2 - Low probability

Hazardous Event Classification		
Rationale (for exposure)	**Severity (of potential harm)**	**Rationale (for severity)**
night driving in the city is a regular	S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low

Hazardous Event Classification		
Rationale (for exposure)	**Severity (of potential harm)**	**Rationale (for severity)**
night driving in the city is a regular	S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low
night driving in the city on	S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low
High driving is part of regular	S3 - Life-threatening or fatal injuries	On highway speed of vehicle is expected to be high
country driving is part of regular	S3 - Life-threatening or fatal injuries	On country roads speed of vehicle is expected to be
country driving is part of regular	S3 - Life-threatening or fatal injuries	On country roads speed of vehicle is expected to be

		Determination of ASIL and Safety Goals	
Controllability (of hazardous event)	**Rationale (for controllability)**	**ASIL Determination**	**Safety Goal**
C0 - Controllable in general	At city speed, most drivers will be able to	QM	Total Loss of Beam

		Determination of ASIL and Safety Goals	
Controllability (of hazardous event)	**Rationale (for controllability)**	**ASIL Determination**	**Safety Goal**
C0 - Controllable in general	At city speed, most drivers will be able to	QM	Total loss of low beam
C1 - Simply controllable	On completely unilluminated city roads,	QM	Total loss of low beam
C2 - Normally controllable	When driving on highway with low beam, it	A	Total loss of low beam
C1 - Simply controllable	Since there is usually no other form of	B	Total loss of low beam
C3 - Difficult to control or uncontrollable	Since there is usually no other form of	B	Total loss of low beam

Hazard & Risk Analysis Definiti

Operational Mode

ID	Mode
OM01	Parked
OM02	Ignition on
OM03	Normal driving
OM04	Backward driving
OM05	Degraded driving
OM06	Towing (active)
OM07	Towing (passive)
OM08	Service
OM09	N/A

Operational Scenario

ID	Scenario
OS01	Any Road
OS02	City Road
OS03	Country Road
OS04	Highway
OS05	Mountain Pass
OS06	Off Road
OS07	Road with gradient
OS08	Road with bump
OS09	Road tunnel
OS10	Road with construction site
OS11	N/A

Situation Details

ID	Scenario
SD01	Low speed
SD02	High speed
SD03	Normal acceleration
SD04	High acceleration
SD05	Normal braking
SD06	High braking
SD07	N/A

Item Usage

ID	Mode
IU01	Correctly used
IU02	Incorrectly used
IU03	N/A

Environmental Details

ID	Scenario
EN01	Normal conditions
EN02	Sun blares (degraded view)
EN03	Fog (degraded view)
EN04	Snowfall (degraded view)
EN05	Cross-wind (lateral force)
EN06	Rain (slippery road)
EN07	Snow (slippery road)
EN08	Glace (slippery road)
EN09	N/A

ions

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

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

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

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

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

Deviation

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

Hazardous Events (possibe effects)

ID	Hazardous Event	Remarks
EV-07	None	
EV-06	Front collision with oncoming traffic	
EV-05	Front collision with ahead traffic	
EV-04	Front collision with obstacle	
EV-03	Rear collision with trailing traffic	

EV-02	Side collision with other traffic	
EV-01	Side collision with obstacle	
EV00	Collision with other vehicle	
EV01	Collision with train	
EV02	Collision with pedestrian	
EV03	Car spins out of control	
EV04	Car comes off the road	
EV05	Car catches file	
EV06	N/A	

Reference
DV01 - Function not activated
DV02 - Function unexpectedly activated
DV03 - Function always activated
DV04 - Actor effect is too much
DV05 - Actor effect is too less
DV06 - Actor action too early
DV07 - Actor action too late
DV08 - Actor action before
DV09 - Actor action after
DV10 - Actor effect is reverse
DV11 - Actor effect is wrong
DV12 - Sensor sensitivity is too high
DV13 - Sensor sensitivity is too low
DV14 - Sensor detection too early
DV15 - Sensor detection too late
DV16 - Sensor detection before
DV17 - Sensor detection after
DV18 - Sensor detection is reverse
DV19 - Sensor detection is wrong
DV20 - N/A

Reference
EV-07 - None
EV-06 - Front collision with oncoming traffic
EV-05 - Front collision with ahead traffic
EV-04 - Front collision with obstacle
EV-03 - Rear collision with trailing traffic

EV-02 - Side collision with other traffic
EV-01 - Side collision with obstacle
EV00 - Collision with other vehicle
EV01 - Collision with train
EV02 - Collision with pedestrian
EV03 - Car spins out of control
EV04 - Car comes off the road
EV05 - Car catches file
EV06 - N/A

Exposure

ID	Description	Duration (of situation)
E0	Incredible	
E1	Very low probability	Not specified
E2	Low probability	<1 % of average operating time
E3	Medium probability	1 % to 10 % of average operating time
E4	High probability	>10 % of average operating time

Severity

ID	Description	Remarks
S0	No injuries	No injuries
S1	Light and moderate injuries	Light and moderate injuries
S2	Severe and life-threatening injuries	Severe and life-threatening injuries (survival probable)
S3	Life-threatening or fatal injuries	Life-threatening injuries (survival uncertain), fatal injuries

Controllability

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

Frequency (of situation)	Reference
	E0 - Incredible
Occurs less often than once a year for the great majority of drivers	E1 - Very low probability
Occurs a few times a year for the great majority of drivers	E2 - Low probability
Occurs once a month or more often for an average driver	E3 - Medium probability
Occurs during almost every drive on average	E4 - High probability

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

	Reference
	C0 - Controllable in general
ble to avoid harm	C1 - Simply controllable
ble to avoid harm	C2 - Normally controllable
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